

BELLCOMM, INC.

955 L'ENFANT PLAZA NORTH, S.W.

WASHINGTON, D.C. 20024

B63 07025

SUBJECT: Spectrum Analyses of Apollo 10
S-IVB First and Second Burn
Case 320

DATE: July 9, 1969

FROM: A. T. Ackerman
L. A. Ferrara, Jr.

MEMORANDUM FOR FILE

As a possible contribution to diagnosis of the 19 Hz and 45 Hz oscillations in the S-IVB, spectrum analyses of a number of Apollo 10 S-IVB and CM flight measurements have been made and resulting spectrograms are attached as Appendix A.

The spectrograms of the different measurements show many similarities and can be used to derive composite vehicle responses. Figure I shows a composite axial response and identifies the measurements that displayed each frequency-time component. Figure II repeats the axial response on a larger scale and Figures III, IV and V represent the composite pitch, yaw and engine responses. Figure VI compares the axial response observed to the modal frequencies generated by MSFC for POGO analysis.

The principal indications from the spectrum analyses are:

1. A distinct coupling exists between the propulsion system and structure starting at approximately 17.5 Hz, 40 seconds into the first burn and ending at 19.5 Hz, 80 seconds into the first burn. Vehicle responses, Figures I, II, III, IV and V are noted at these same frequencies and time in all three axes of the CM and launch vehicle as well as in the engine measurements; this is consistent with the report of the flight crew. The axial response appears to be dominant; in particular, the gimbal block response appears to persist throughout the first burn, Appendix A, Figure 11.

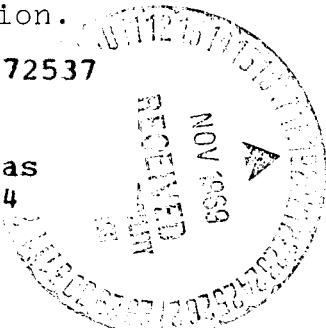
2. The 45 Hz oscillation occurring during the second burn, is shown in the spectrograms. It is observed, Figures I, II, III and IV to begin at approximately 280 seconds into the second burn terminating 10 seconds after the second burn with decreasing frequency, 46.5 to 44.5 Hz. The 45 Hz oscillation is not seen in any engine measurement, Figure V. The 45 Hz oscillation was not seen in the gimbal block and IU, pitch and yaw axes, and this is most likely a result of the low frequency cutoff of the instruments rather than an absence of the 45 Hz oscillation.

(NASA-CR-106545) SPECTRUM ANALYSES OF
APOLLO 10 S-4B FIRST AND SECOND BURN
(Bellcomm, Inc.) 53 p

N79-72537

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FF N ^o 601	CR-106545	00/20
(NASA CR OR TMX OR AD NUMBER)		(CATEGORY)
APOLLO 10 S-4B FIRST AND SECOND BURN		



3. The LOX line frequency, Figure V, appears to be 24 Hz during the first burn and 21 Hz during the second burn until MR shift and 24 Hz after MR shift, which follows the engine MR. The MSFC analysis uses a 24 Hz LOX line frequency.

4. The MSFC analytical model of the LM mode and mode 1 appears to be a good representation of the actual vehicle as indicated by the close agreement to the spectrograms, Figure VI. On the other hand, the analytical model does not appear to be a good representation of the second and third mode as they are approximately 5 Hz higher than the vehicle response of the spectrograms, Figure VI.


A. T. Ackerman
L. A. Ferrara, Jr.

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Attachments
Figures I-VI
Appendix A

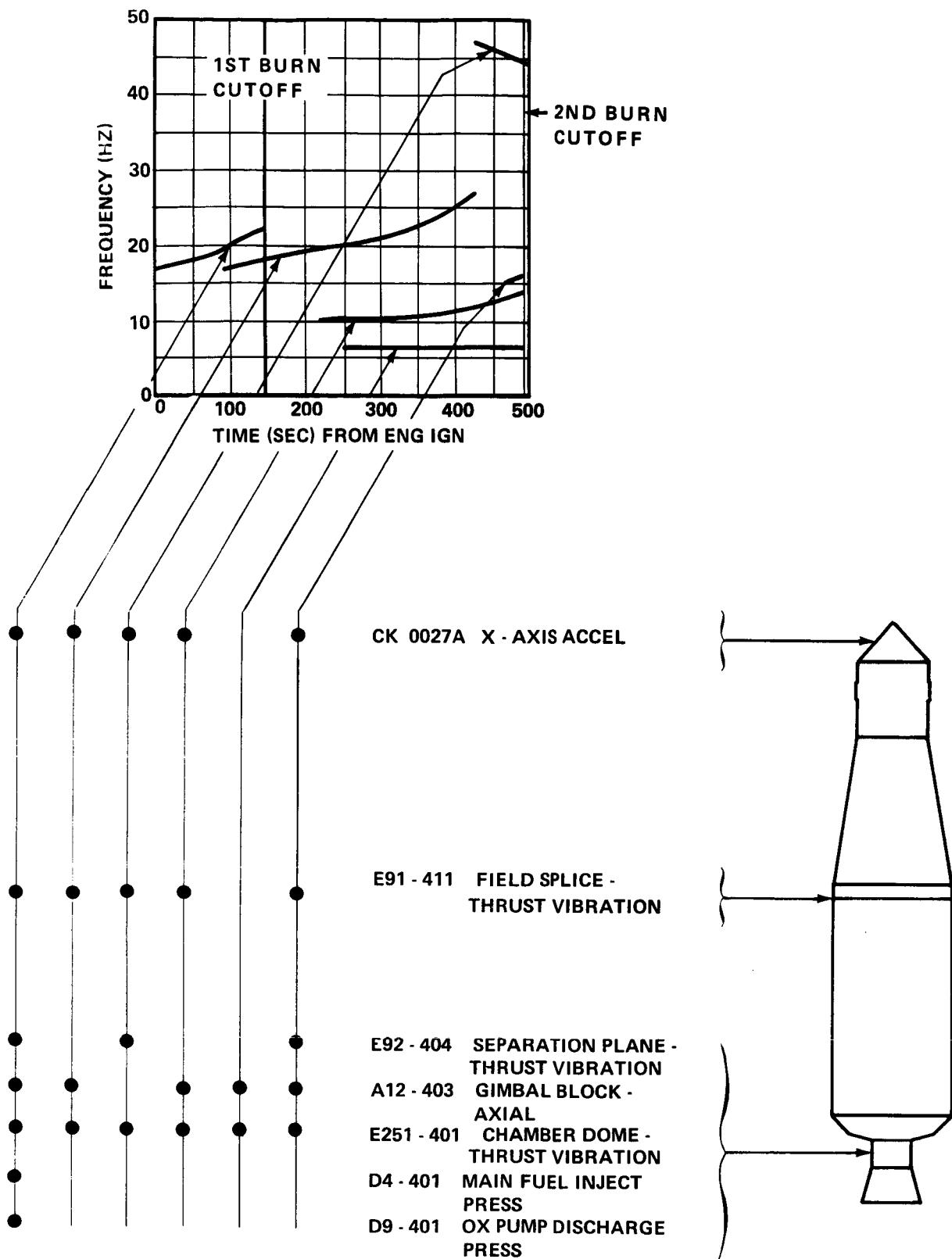


FIGURE I - VEHICLE AXIAL MODAL RESPONSE

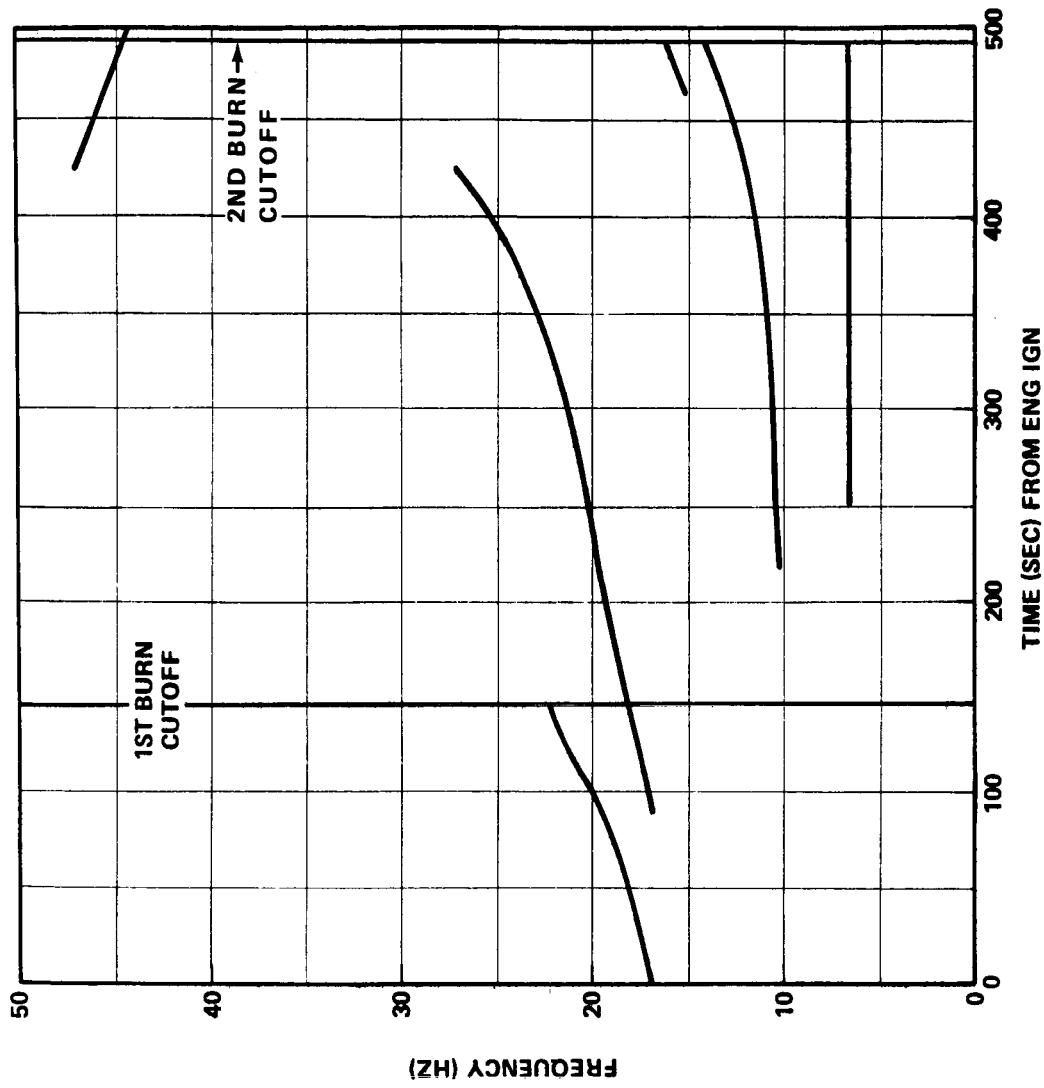


FIGURE II- AXIAL COMPOSITE

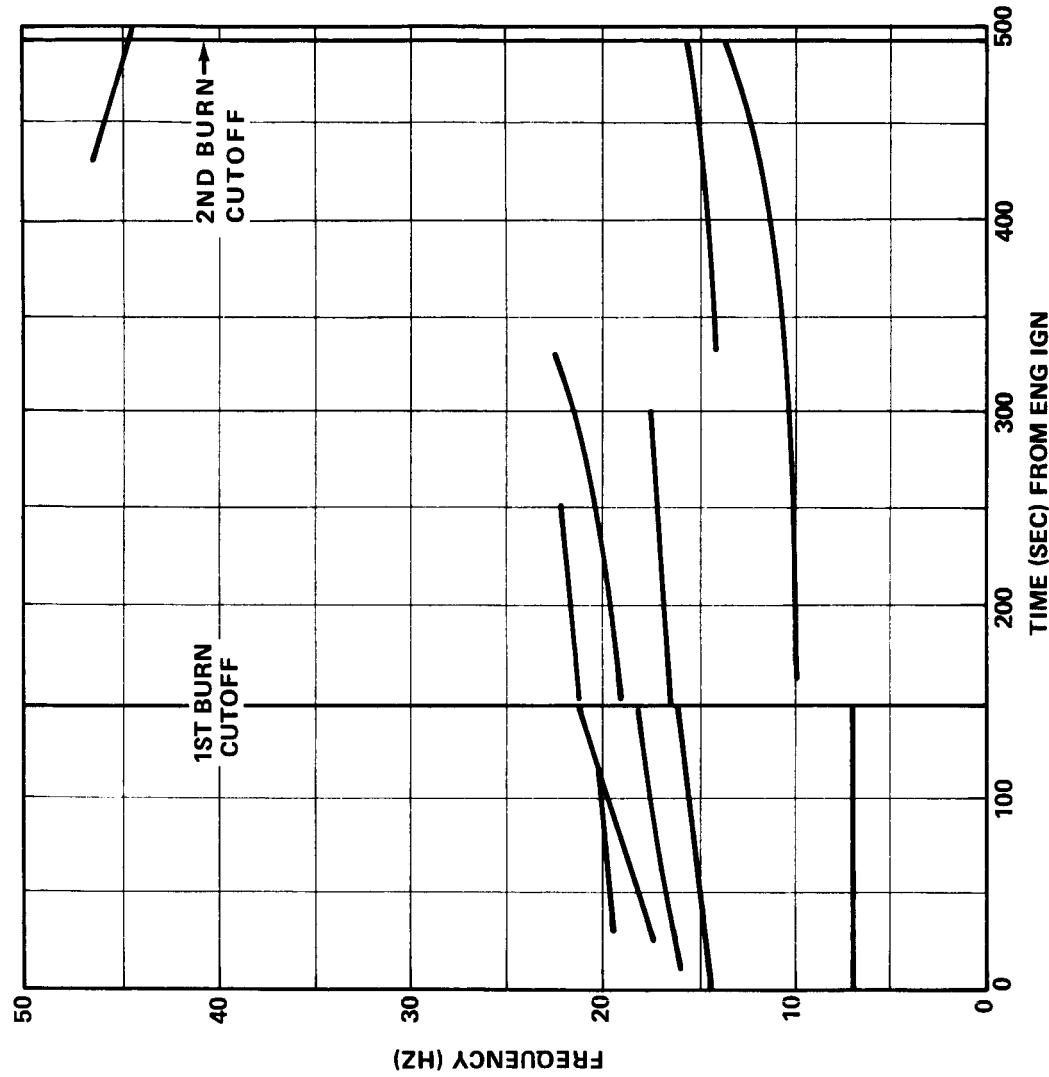


FIGURE III- PITCH COMPOSITE

- 6 -

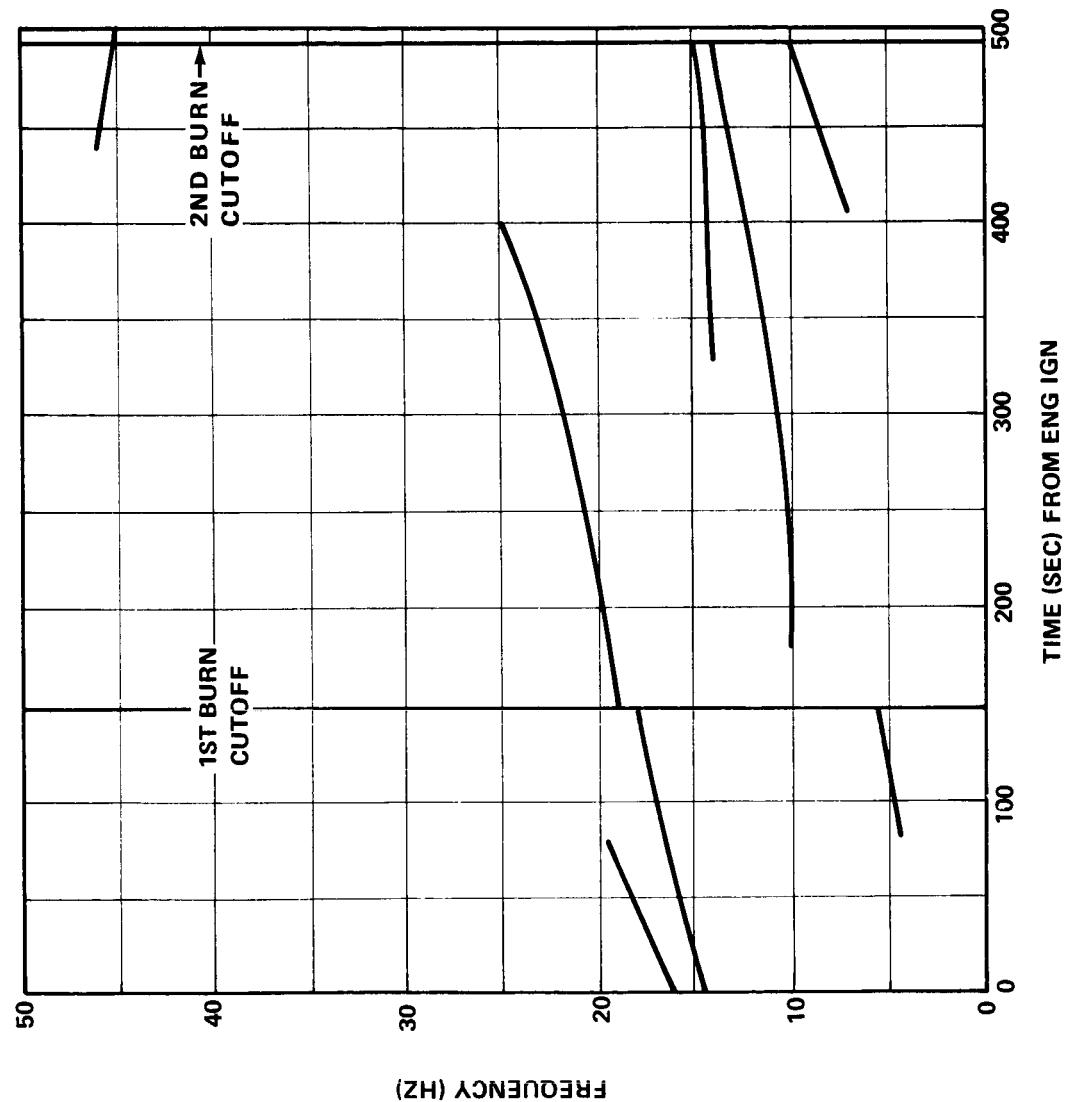


FIGURE IV. YAW COMPOSITE

- 7 -

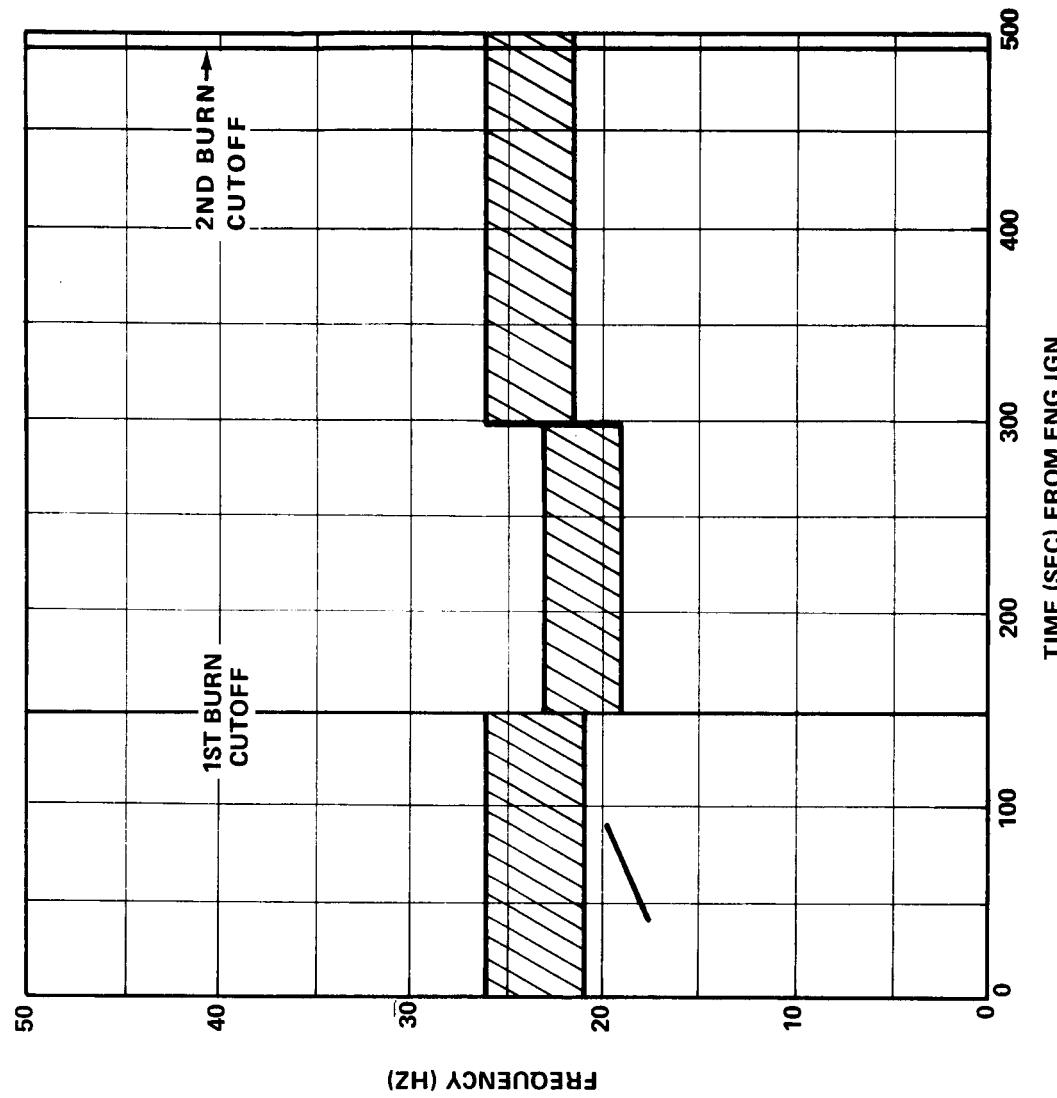
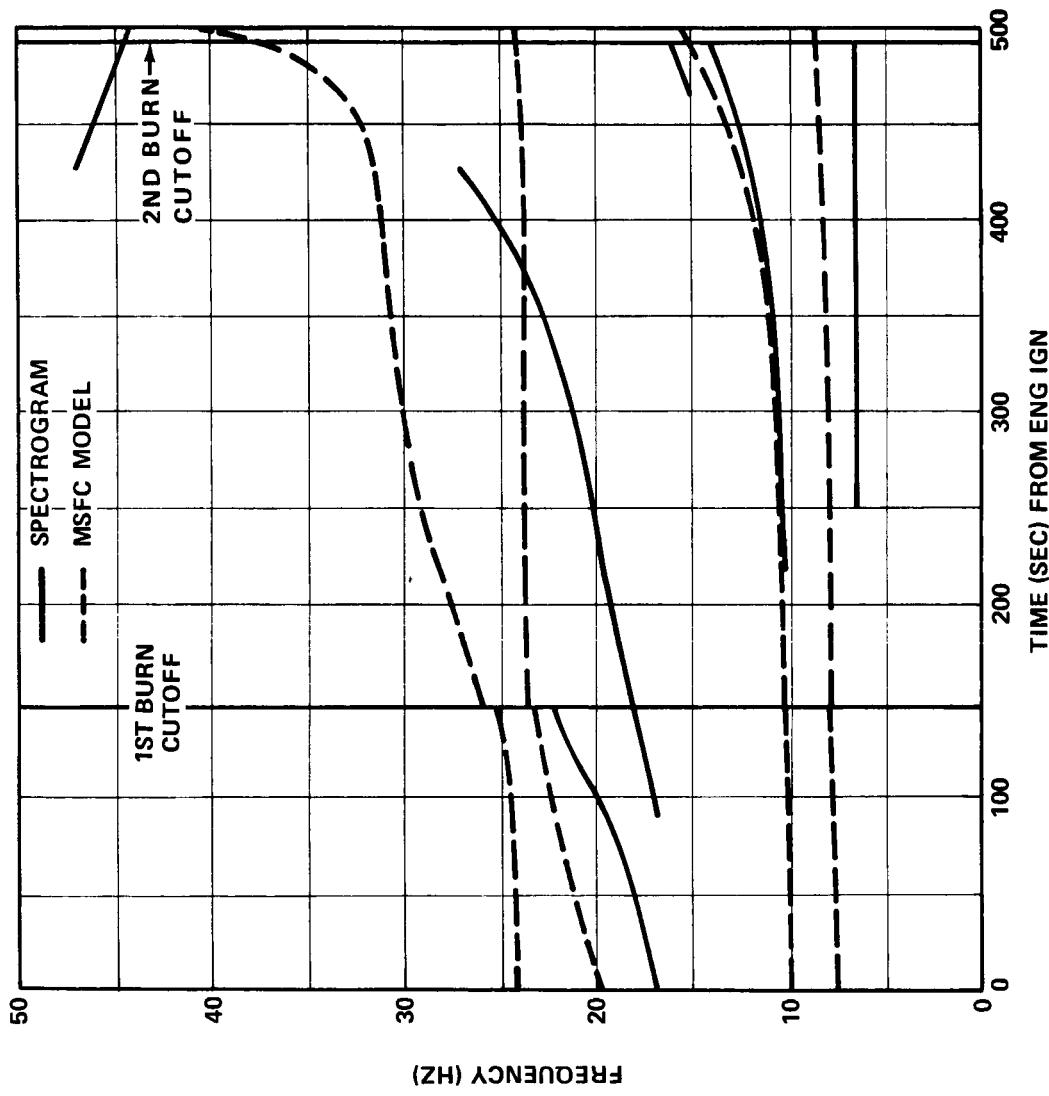


FIGURE V-ENGINE COMPOSITE

FIGURE VI- AXIAL COMPARISON



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APPENDIX A

This Appendix, Figures 1 to 45, contains a series of time-frequency spectrograms which were produced from telemetry recordings of inflight measurements. The measurements were processed on two different analyzers (annotated as "2 bit" and "6 bit").

The "2 bit" analyzer employs "2 bit" digital encoding with hard clipping of the input signal. It has a dynamic range of about 30 dB and a system threshold of -40 dBV. It simultaneously produces the standard 0-150 hertz and 0-50 hertz gram seen in previous spectrum analyses.

The second analyzer is a prototype model employing "6 bit" digital encoding with a greater dynamic range (~60 dB) and lower system threshold (~-65 dBV). Because of the greater dynamic range and higher bit encoding, spectrograms from this analyzer display a higher frequency resolution and a finer granularity when coupled to the spectrogram writer. In either case, it should be remembered that there is considerable amplification of the signals which are displayed and caution should be exercised in deriving conclusions regarding the absolute amplitudes of signals displayed on the spectrogram.

INDEX

Figure No.

Measurement	2 Bit		6 Bit
	150 Hz	50 Hz	150 Hz
D4-401 Main Fuel Injector Pres.	1	2	3
B9-401 Ox Pump Discharge Press.	4	5	6
E251-401 Chamber Dome-Thrust Vibration	7	8	9
A12-403 Gimbal Block-Axial	10	11	12
E92-404 Separation Plane-Thrust Vibration	13	14	15
E91-411 Field Splice-Thrust Vibration	16	17	18
E100-411 FWD Bending Mode-Yaw	19	20	21
A11-403 Gimbal Block-Yaw	22	23	24
A7-603 IU-Yaw	25	26	27
E99-411 FWD Bending Mode-Pitch	28	29	30
A6-603 IU-Pitch	31	32	33
A10-403 Gimbal Block-Pitch	34	35	36
CK0026A CM X-Axis Accel.	37	38	39
CK0027A CM Y-Axis Accel.	40	41	42
CK0028A CM Z-Axis Accel. (High Gain)	43		
CK0028A CM Z-Axis Accel	44		45

AS-505 S-IVB D4-401 MAIN FUEL INJECT PRESS
(2 BIT)

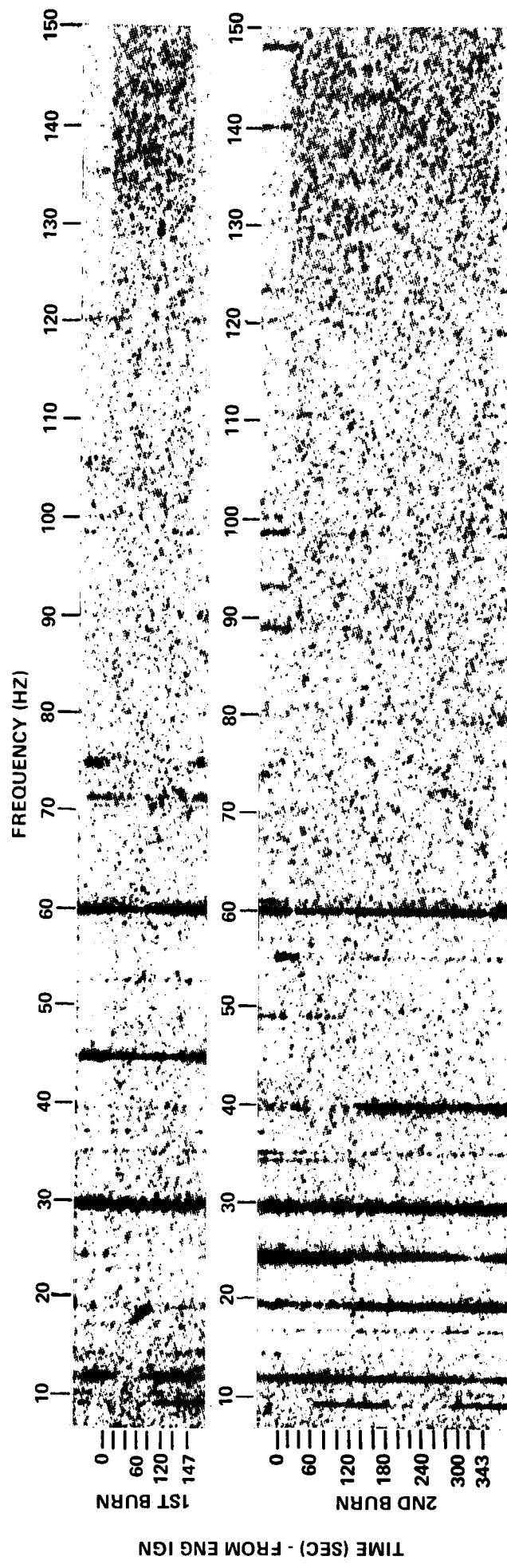


FIGURE 1

AS-505 S-IVB D4-401 MAIN FUEL INJECT PRESS
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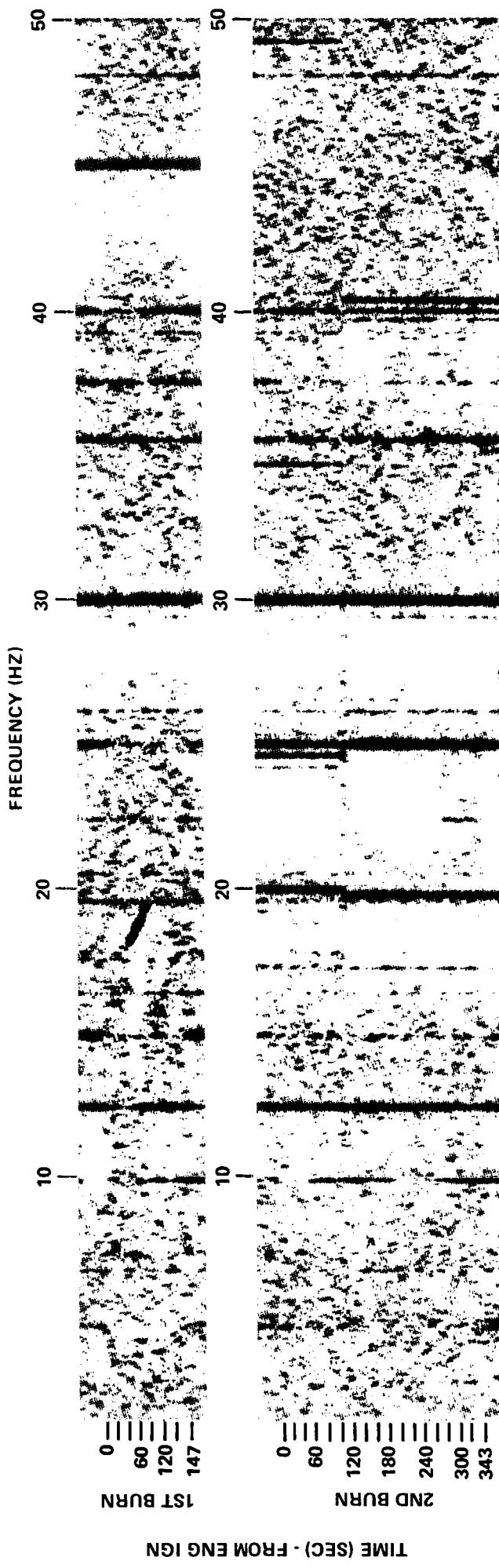


FIGURE 2

AS-505 S-IVB D4-401 MAIN FUEL INJECT PRESS
(6 BIT)

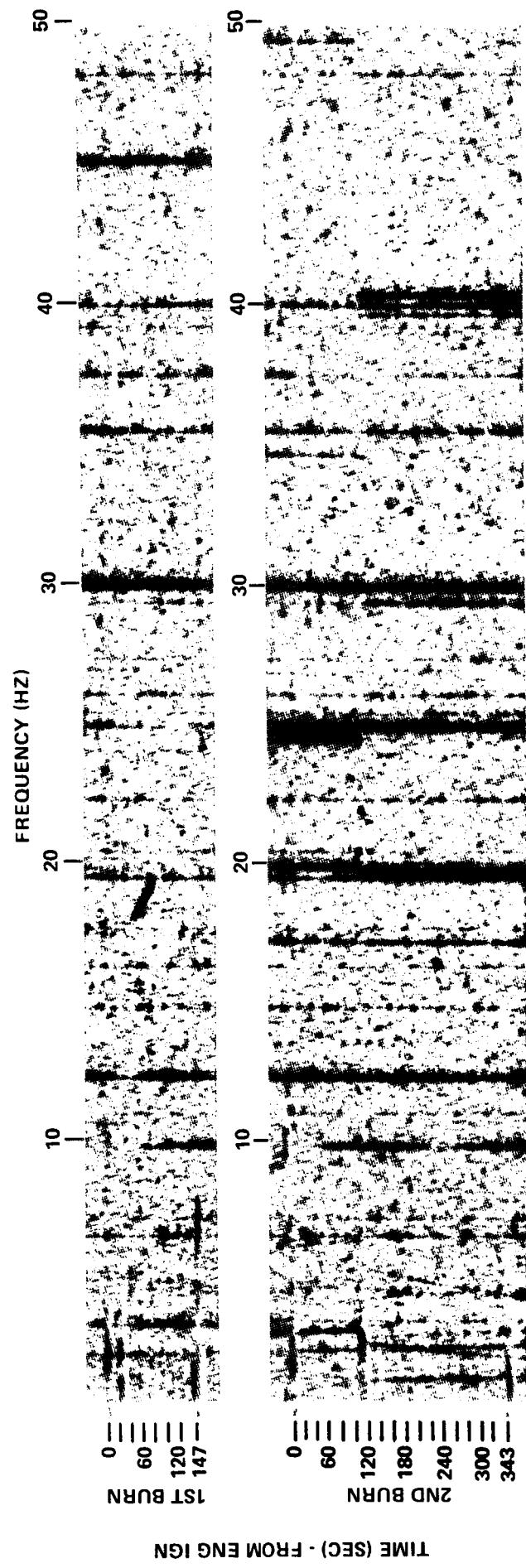


FIGURE 3

AS-505 S-IVB D9-401 OX PUMP DISCHARGE PRESS
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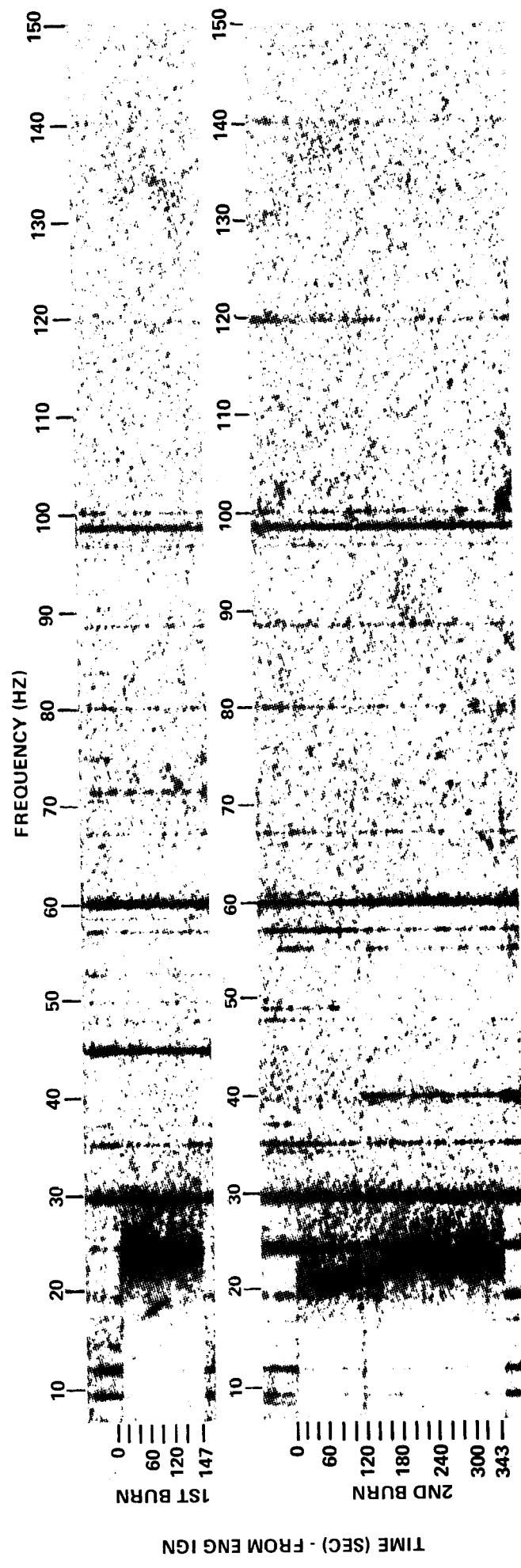


FIGURE 4

AS-505 S-IVB D9-401 OX PUMP DISCHARGE PRESS
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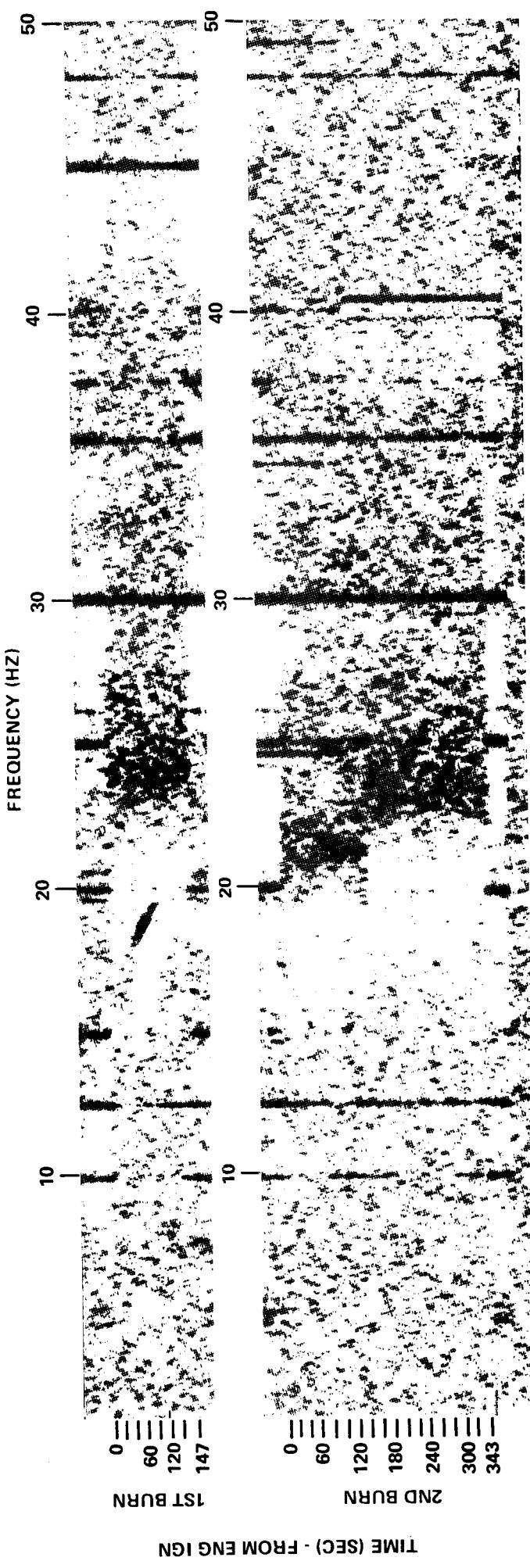


FIGURE 5

AS-505 S-IVB D9-401 OX PUMP DISCHARGE PRESS
(6 BIT)

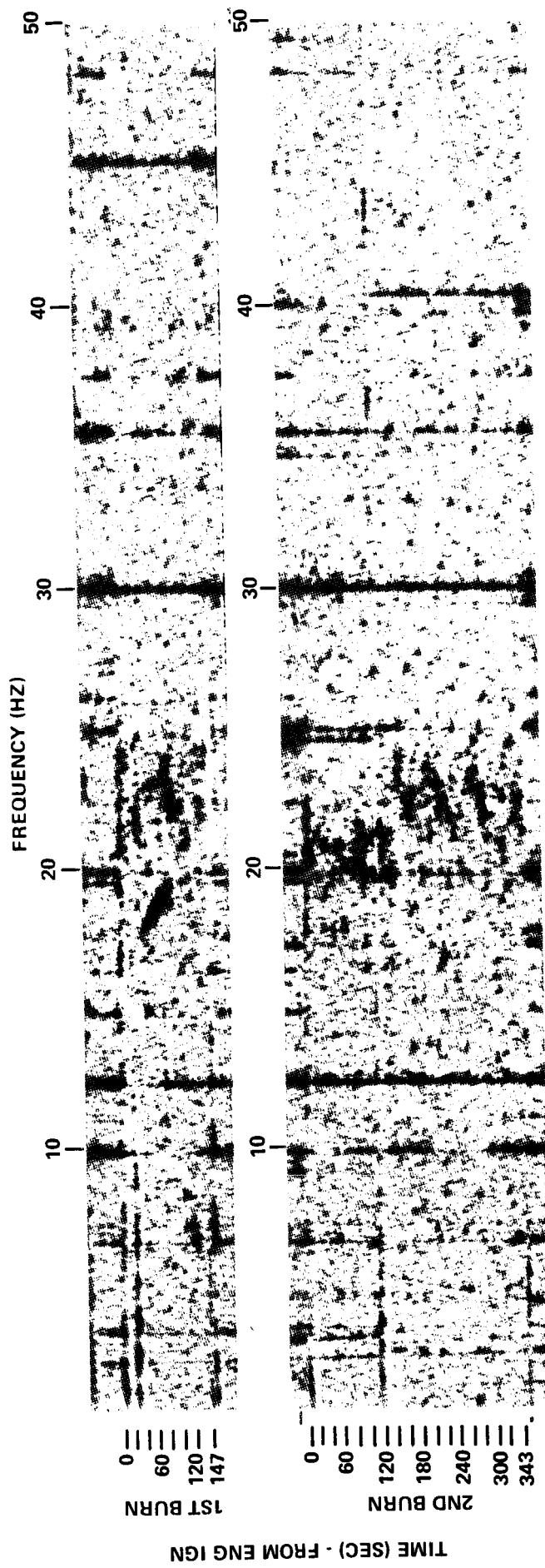


FIGURE 6

AS505 S-IVB E251-401 CHAMBER DOME - THRUST VIBRATION
(2 BIT)

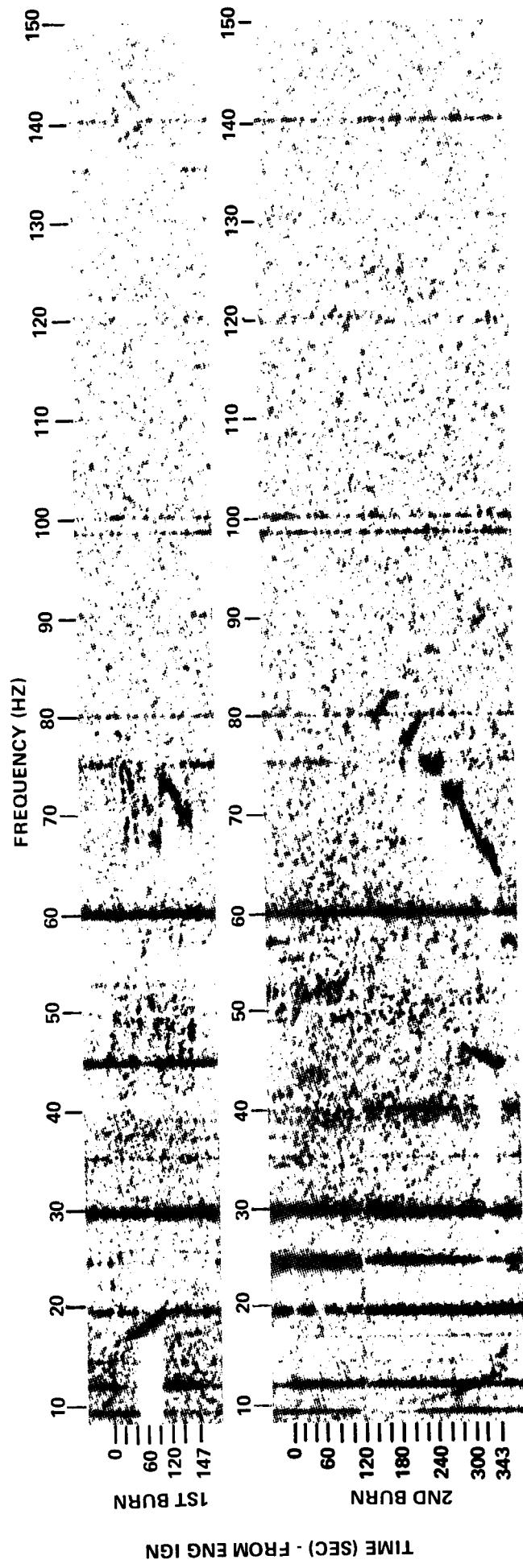


FIGURE 7

AS-505 S-IVB E251-401 CHAMBER DOME - THRUST VIBRATION
(2 BIT)

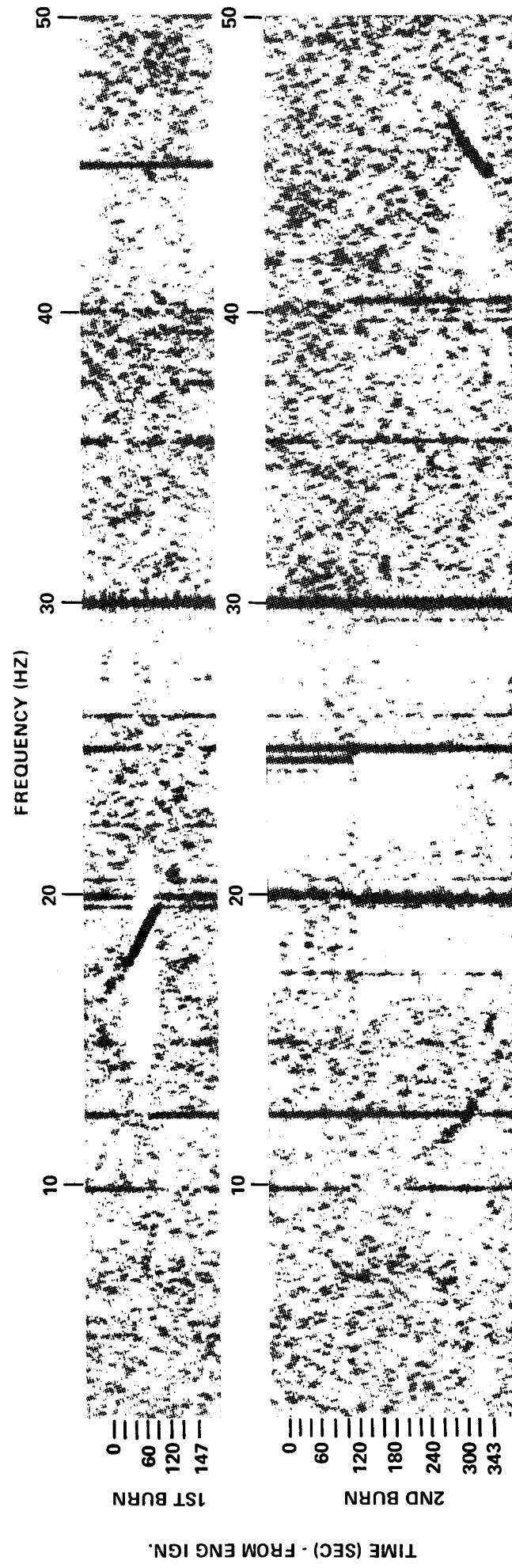


FIGURE 8

AS-505 S-IVB E251-401 CHAMBER DOME - THRUST VIBRATION
(6 BIT)

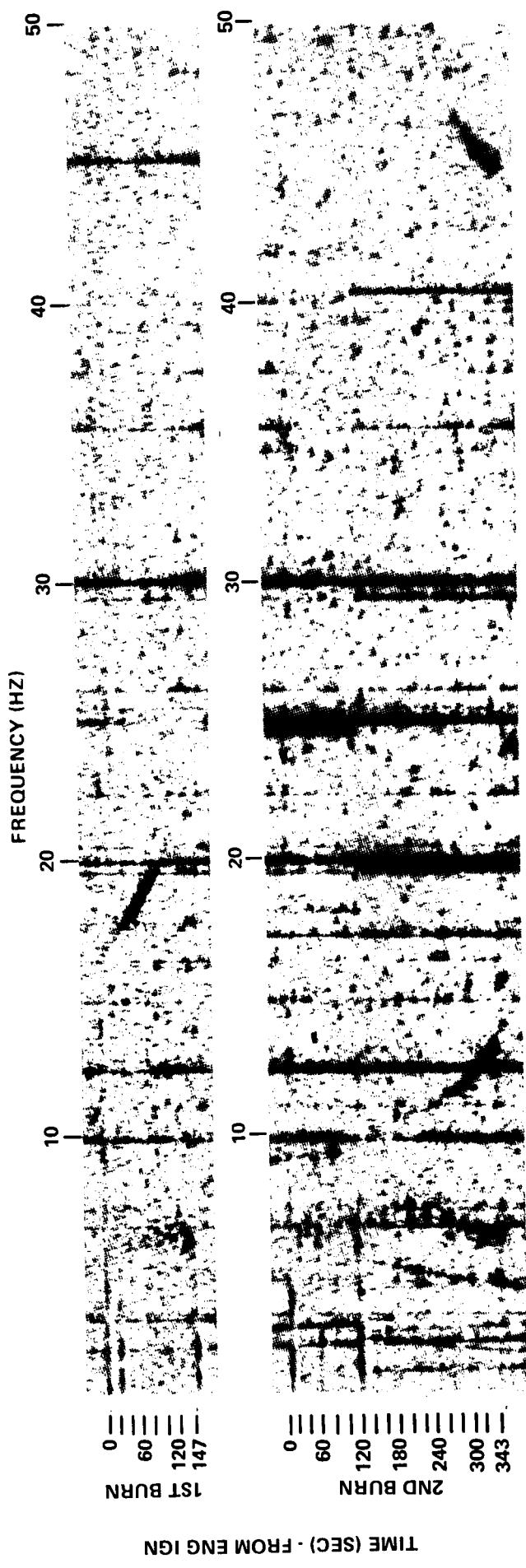


FIGURE 9

**AS-505 S-IVB A12-403 GIMBAL BLOCK - AXIAL
(2 BIT)**

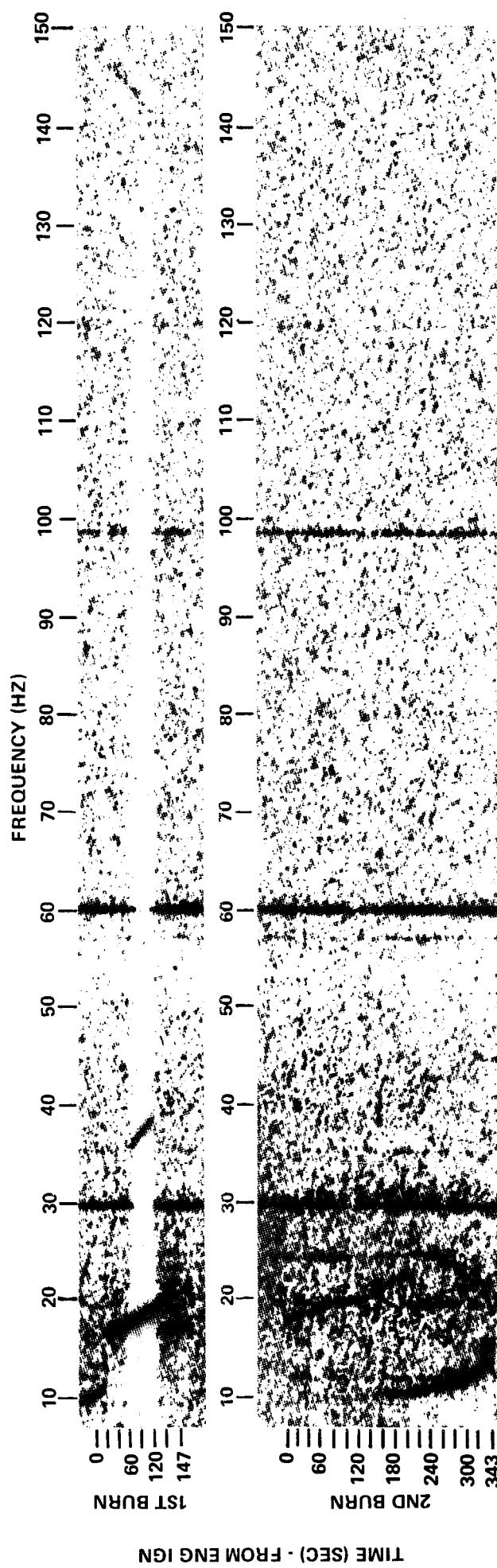


FIGURE 10

AS-505 S-IVB A 12-403 GIMBAL BLOCK - AXIAL
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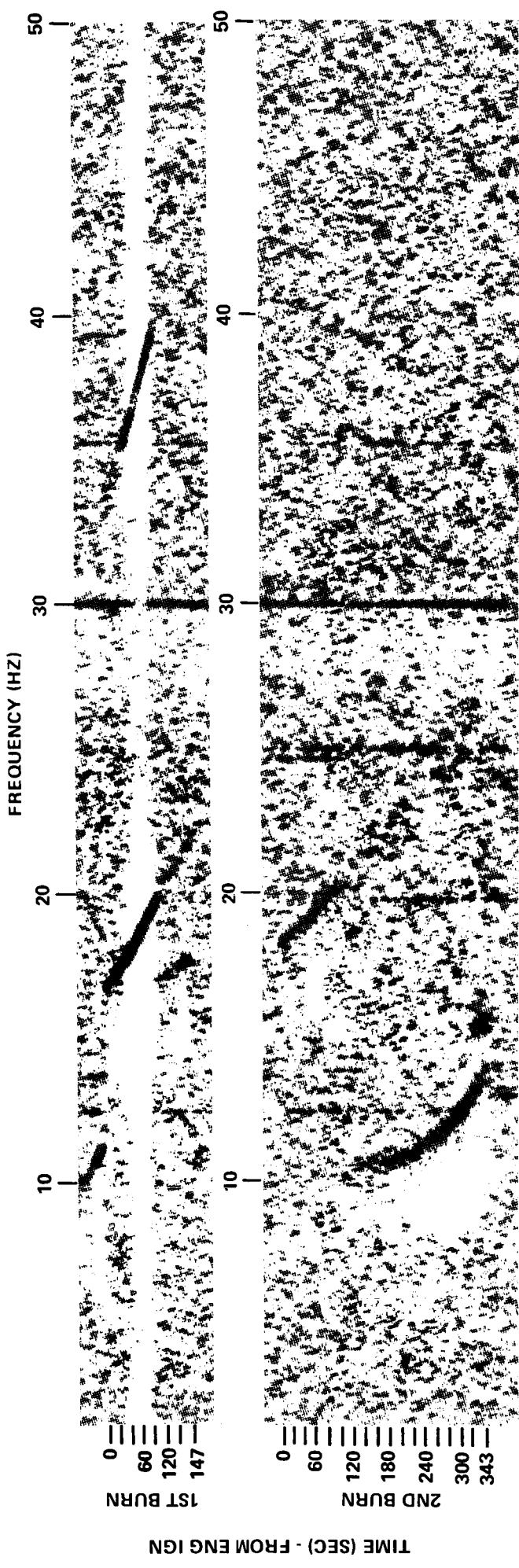


FIGURE 11

AS-505 S-IVB A12-403 GIMBAL BLOCK - AXIAL
(6 BIT)

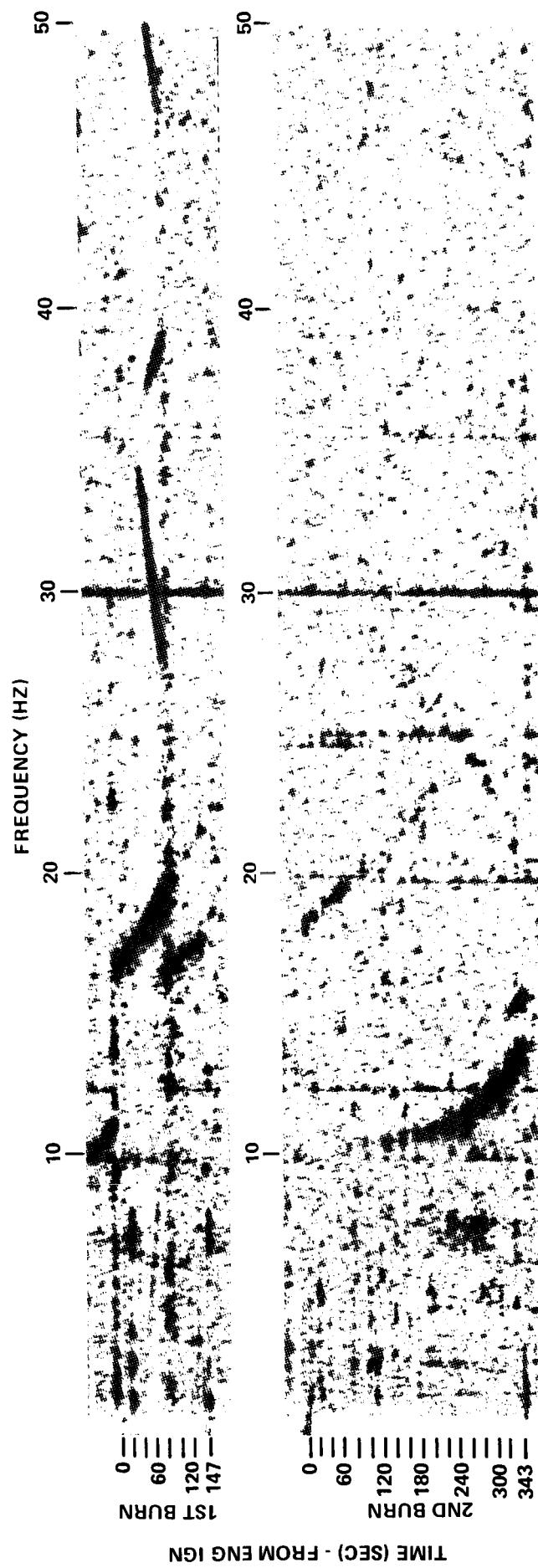


FIGURE 12

AS-505 S-IVB E92-404 SEPARATION PLANE - THRUST VIBRATION
(2 BIT)

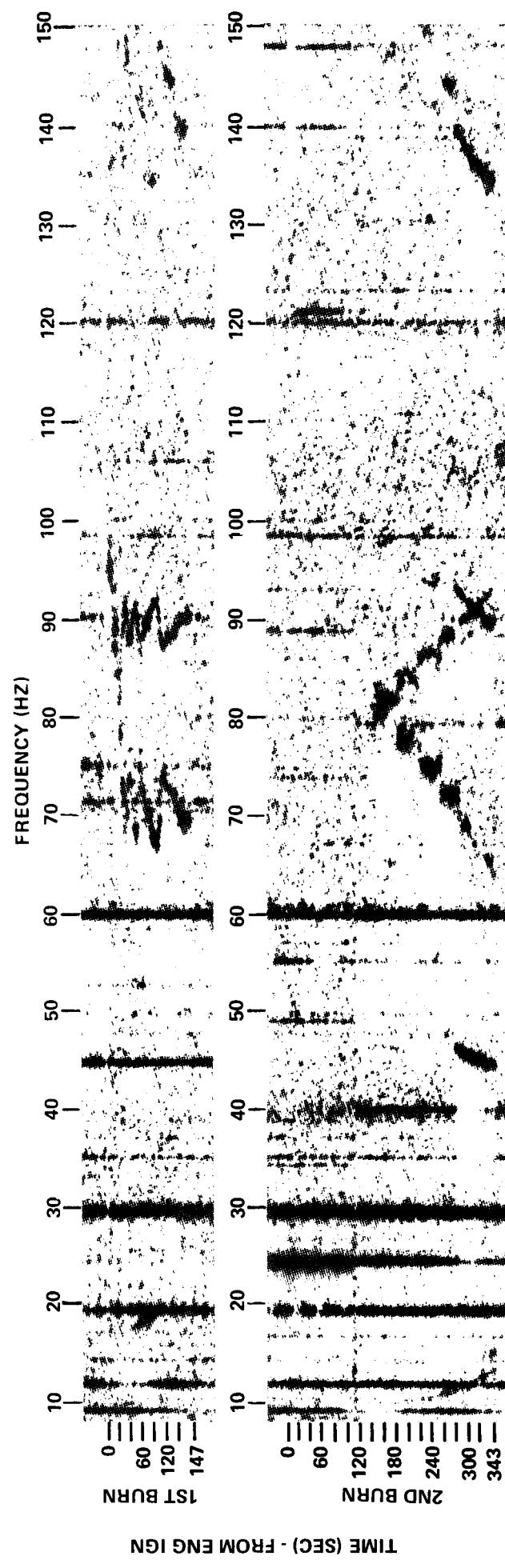


FIGURE 13

AS-505 S-IVB E92-404 SEPARATION PLANE - THRUST VIBRATION
(2 BIT)

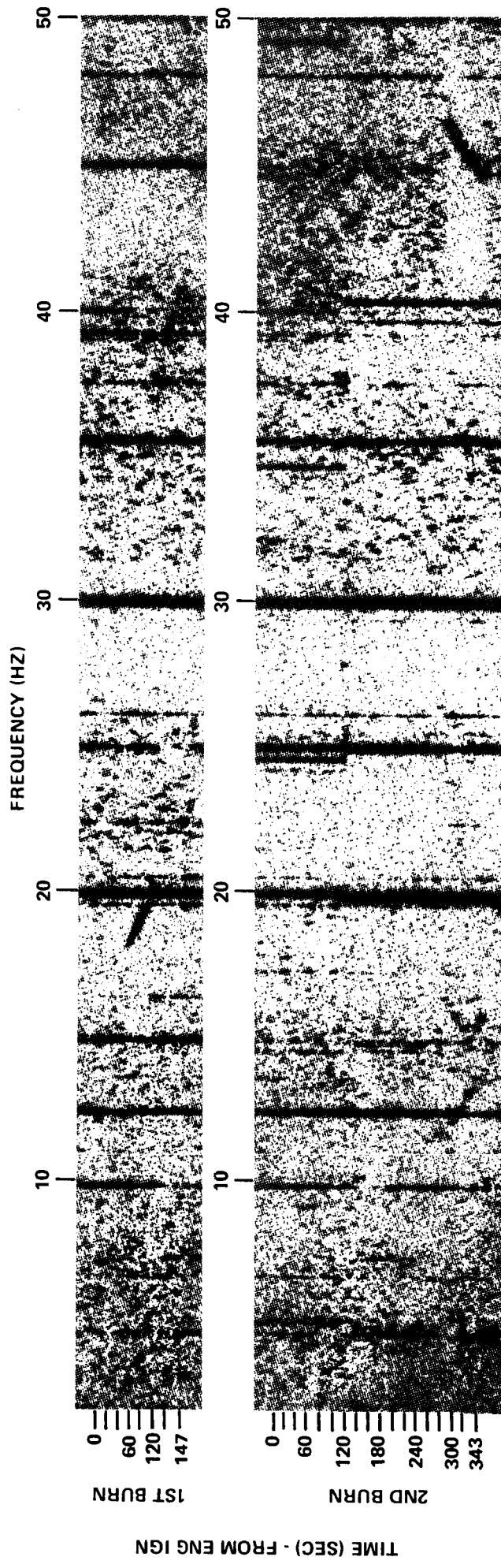


FIGURE 14

AS-505 S-IVB E92-404 SEPARATION PLANE - THRUST VIBRATION
(6 BIT)

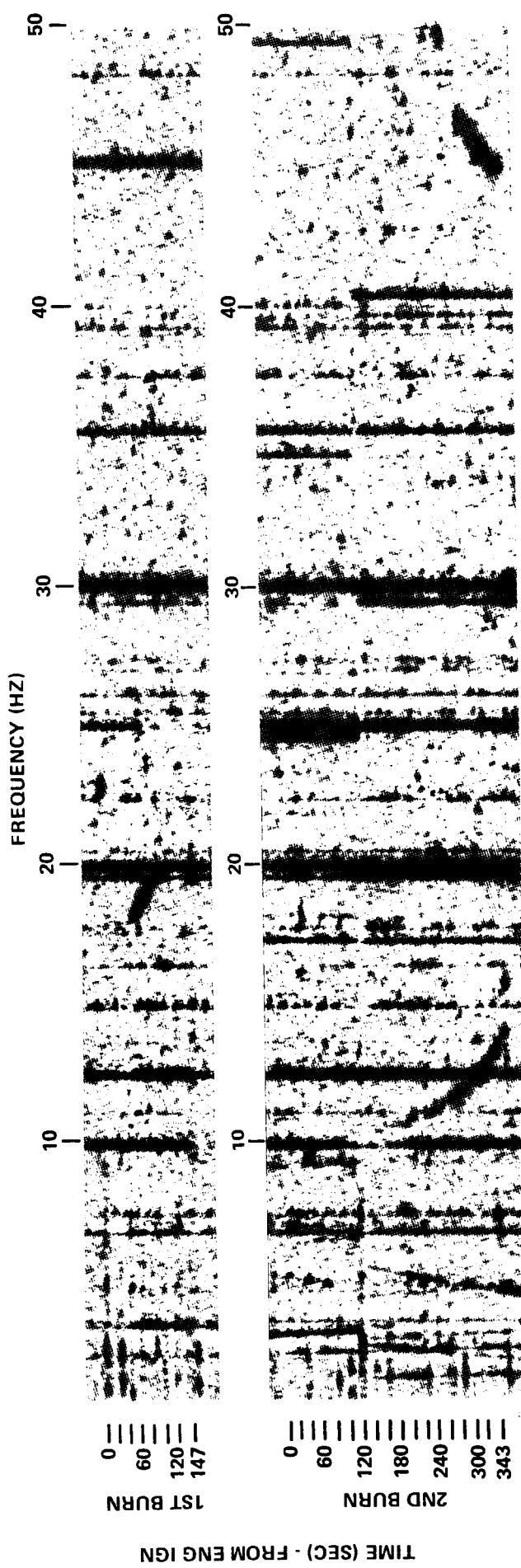


FIGURE 15

AS-505 S-IVB E91411 FIELD SPLICE-THRUST VIBRATION
(2 BIT)

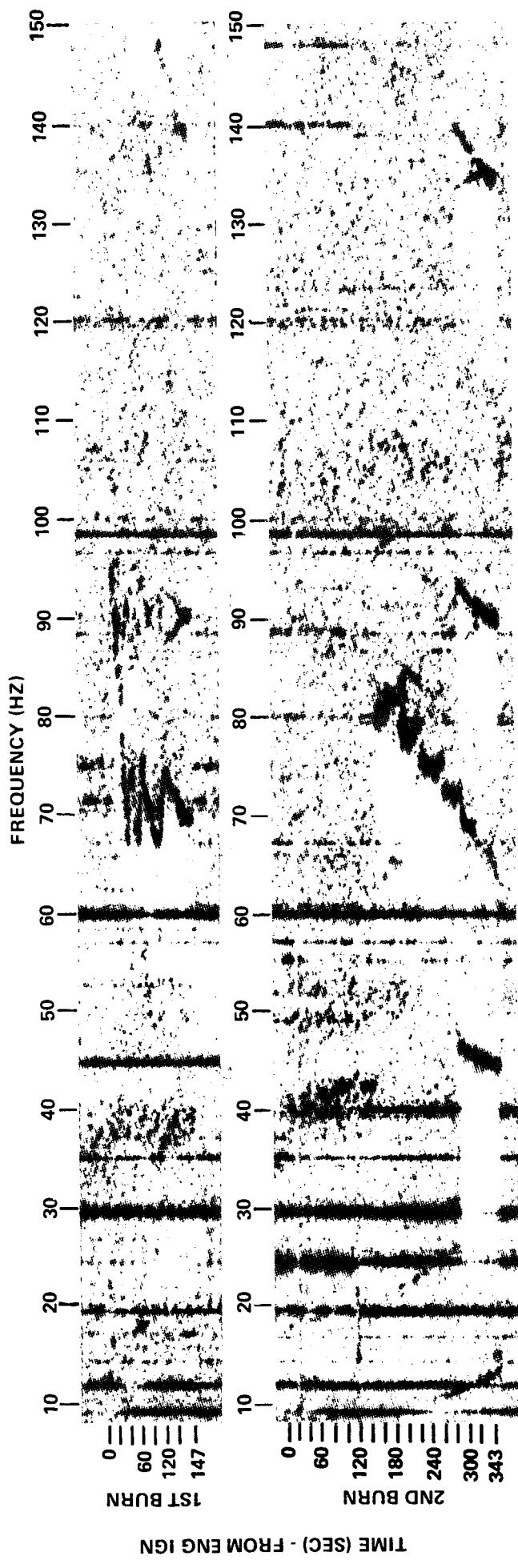


FIGURE 16

AS-505 S/VB E91-411 FIELD SPLICE-THRUST VIBRATION
(2 BIT)

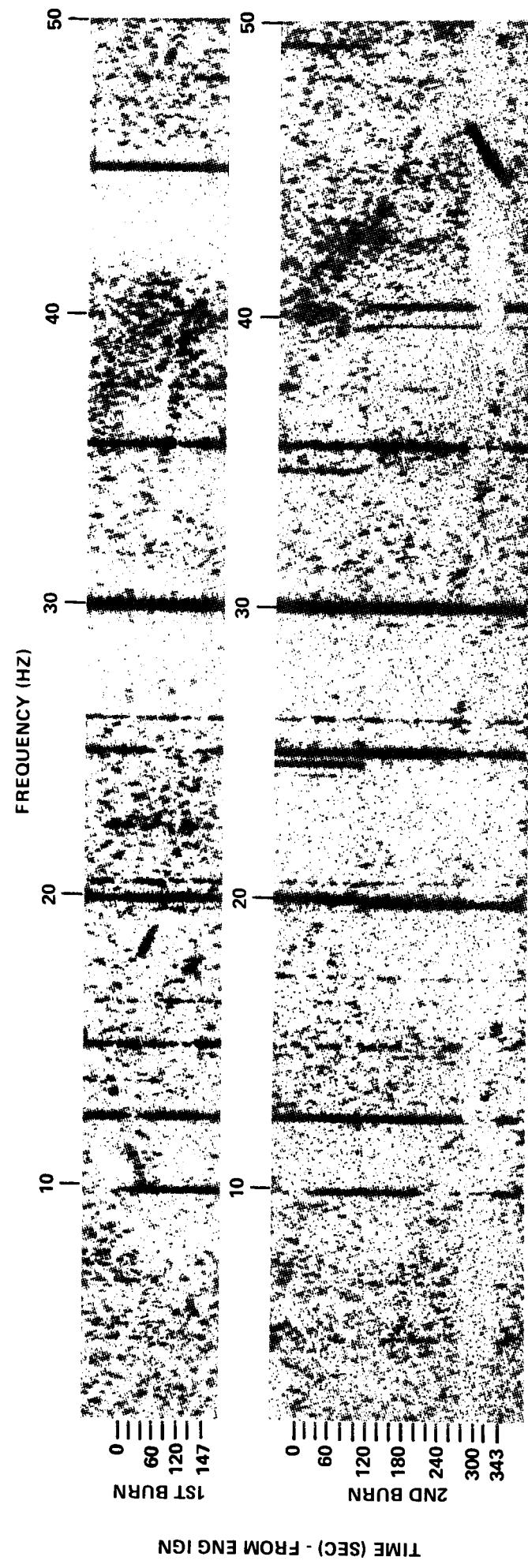


FIGURE 17

AS-505 S-IVB E91-411 FIELD SPLICE-THRUST VIBRATION
(6 BIT)

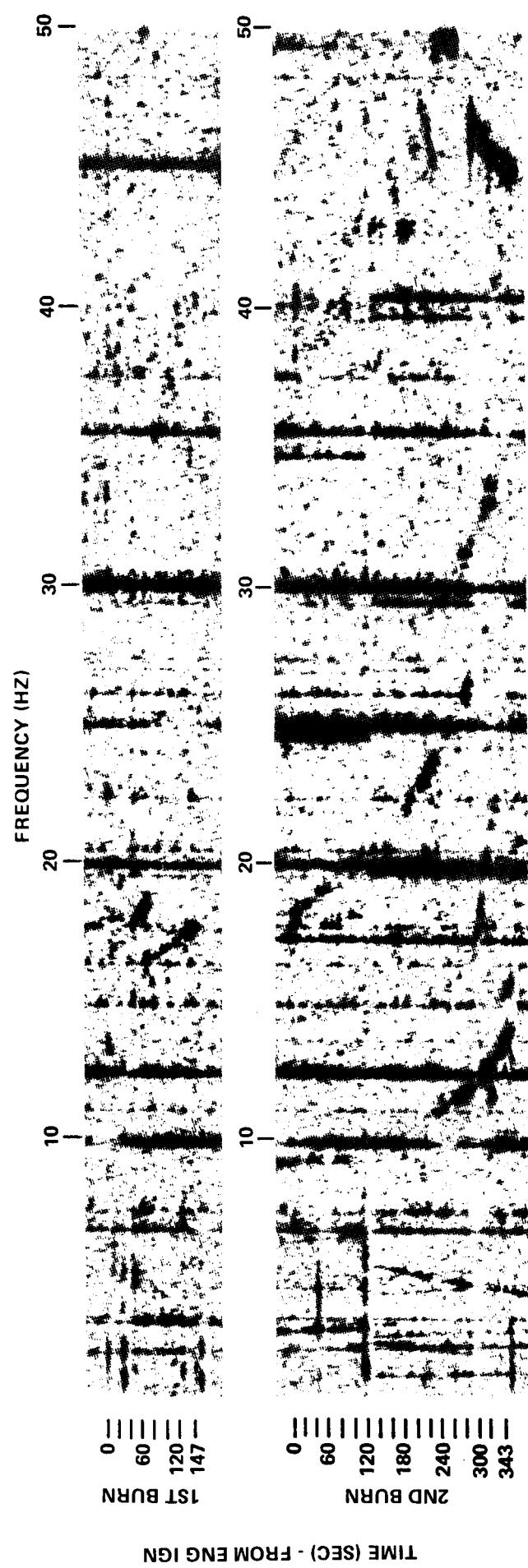


FIGURE 18

AS-505 S-IVB E100-411 FWD BENDING MODE-YAW
(2 BIT)

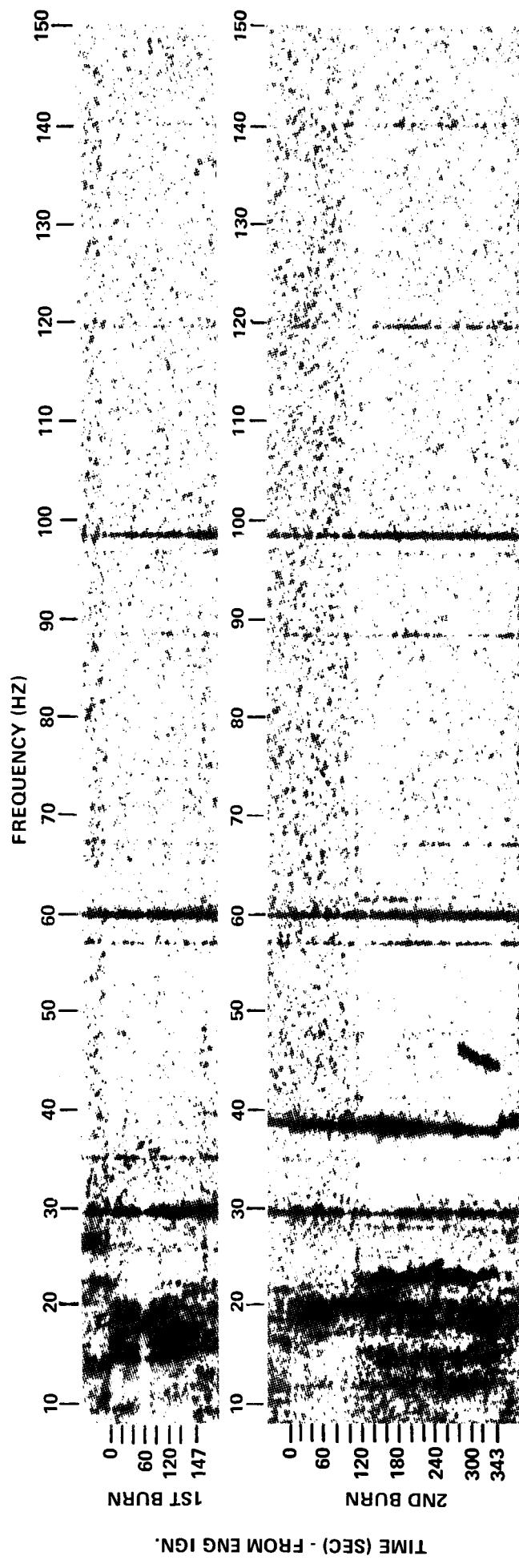


FIGURE 19

AS-505 S-IVB E100-411 FWD BENDING MODE-YAW
(2 BIT)

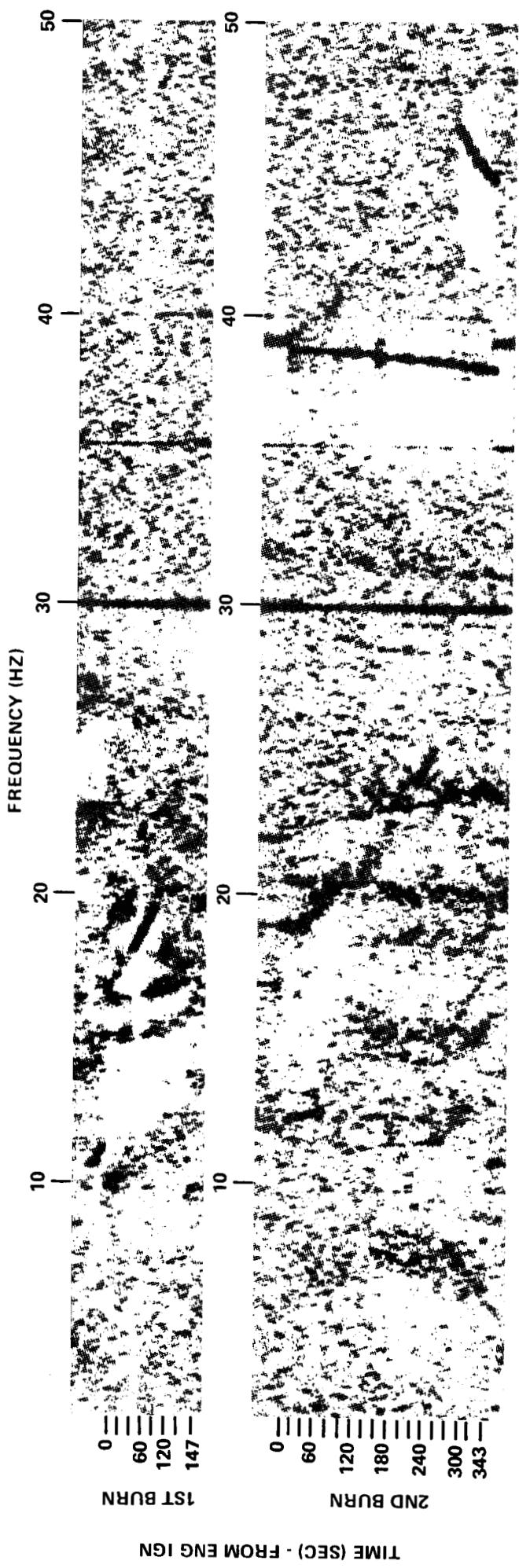


FIGURE 20

AS-505 S-IVB E100-411 FWD BENDING MODE - YAW
(6 BIT)

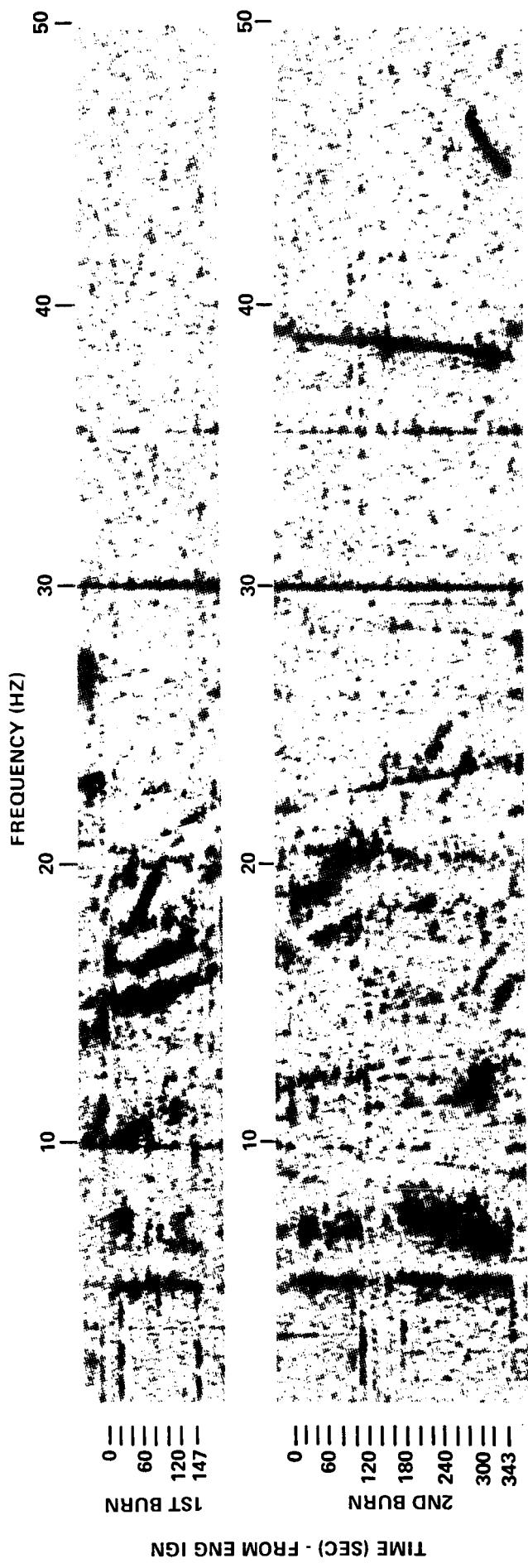


FIGURE 21

AS-505 S-IVB A11-403 GIMBAL BLOCK - YAW
(2 BIT)

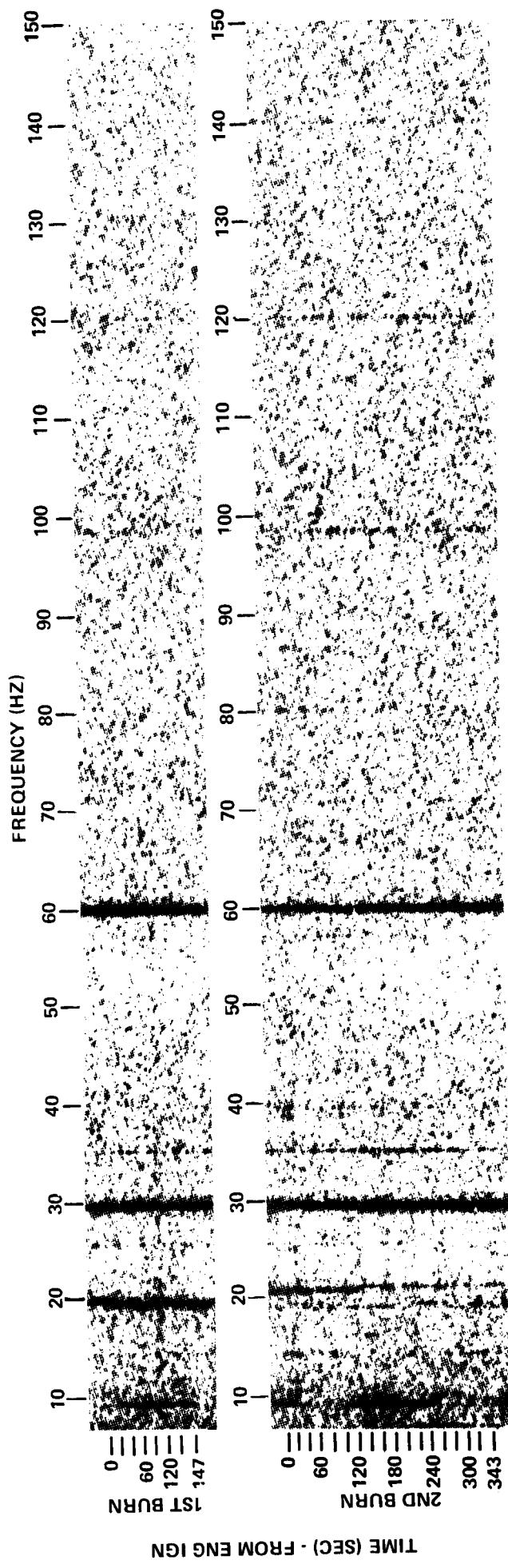


FIGURE 22

AS-505 S-IVB A11-403 GIMBAL BLOCK - YAW
(2 BIT)

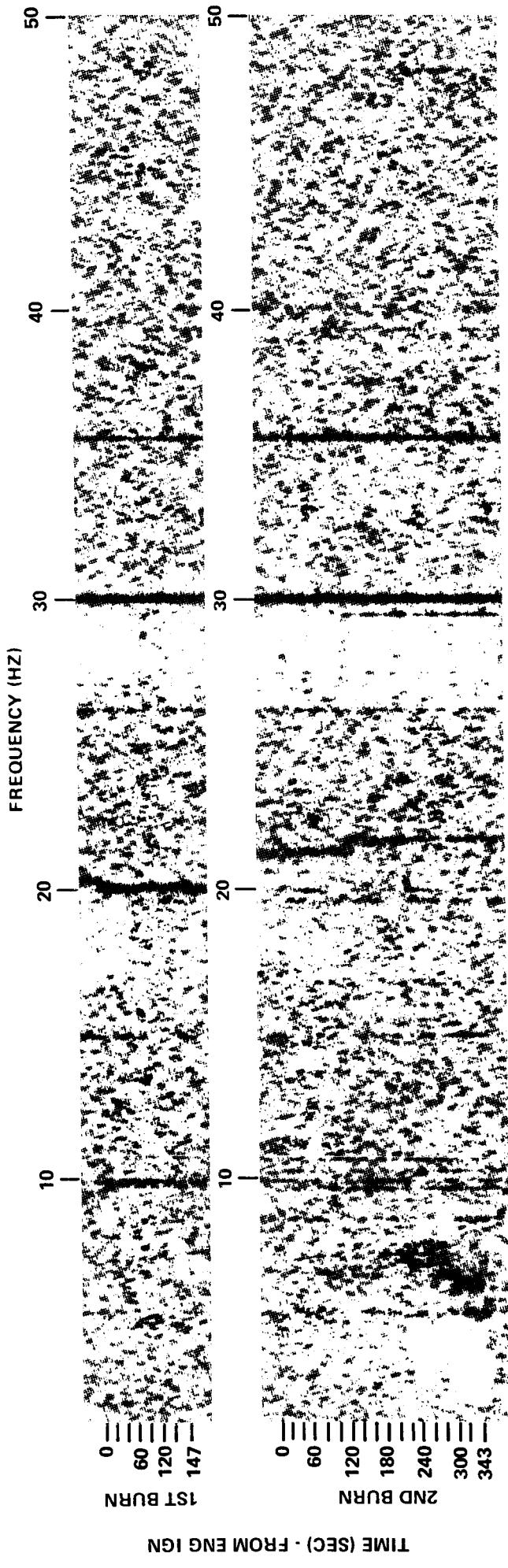


FIGURE 23

AS-505 S-IVB A11403 GIMBAL BLOCK - YAW
(6 BIT)

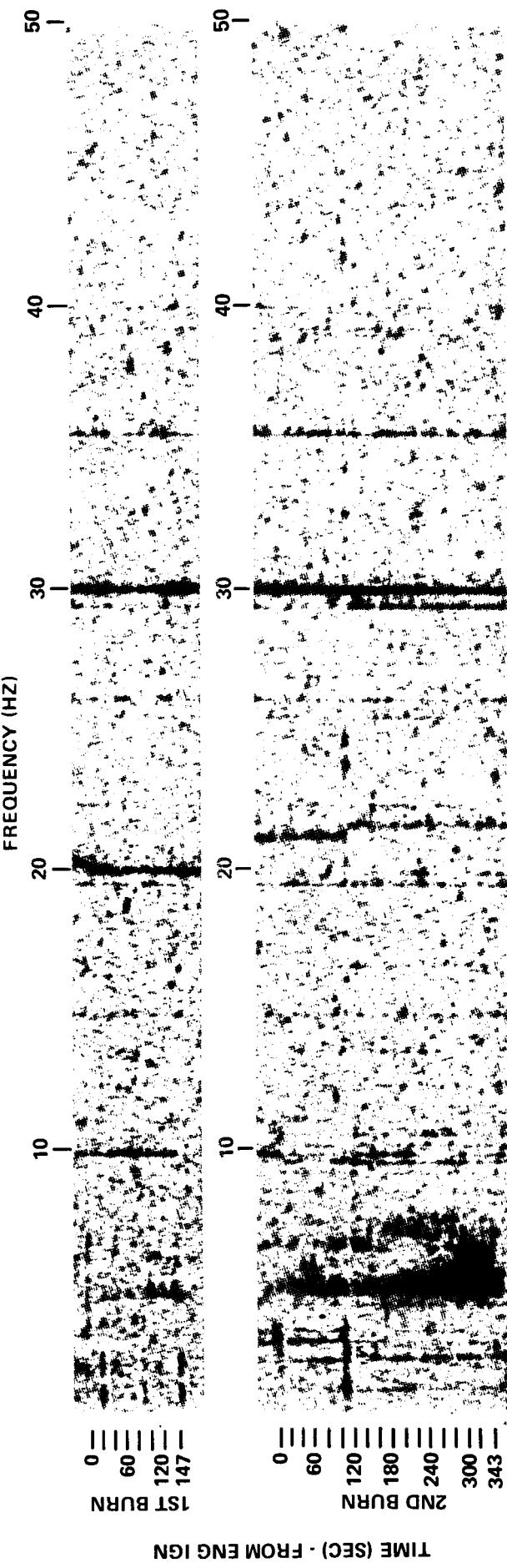
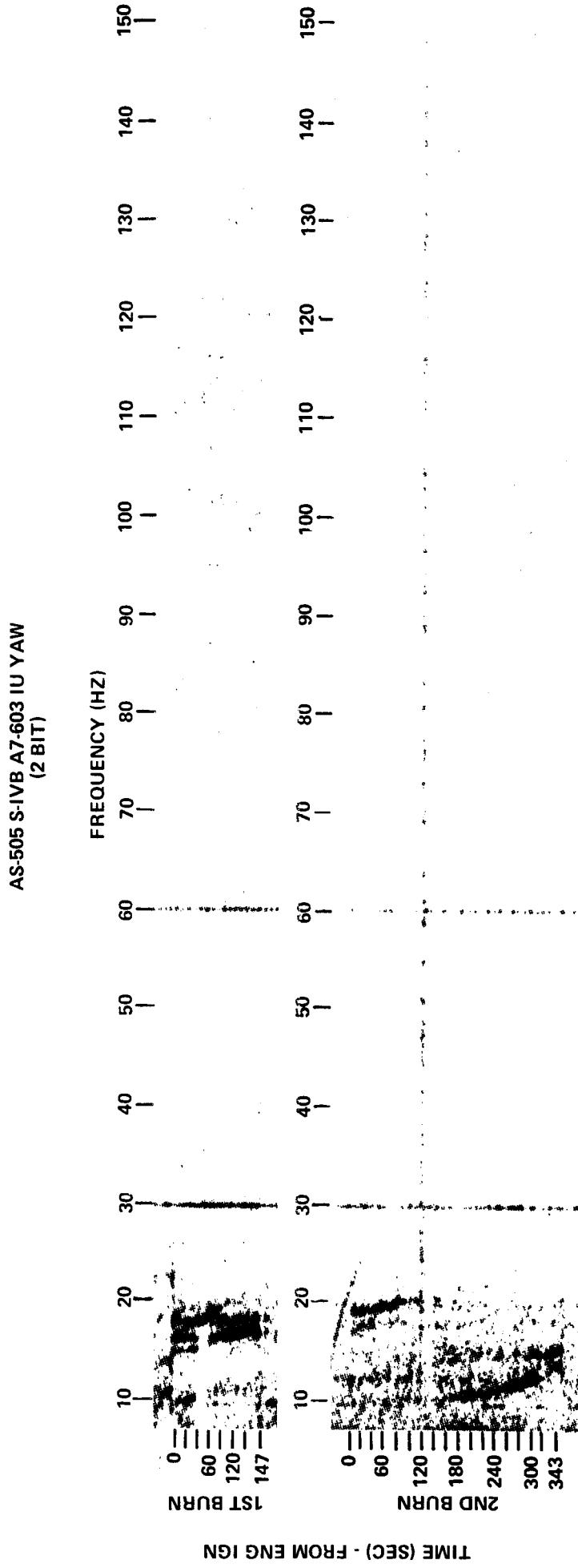


FIGURE 24

FIGURE 25



AS-505 S-IVB A7-603 IU YAW
(2 BIT)

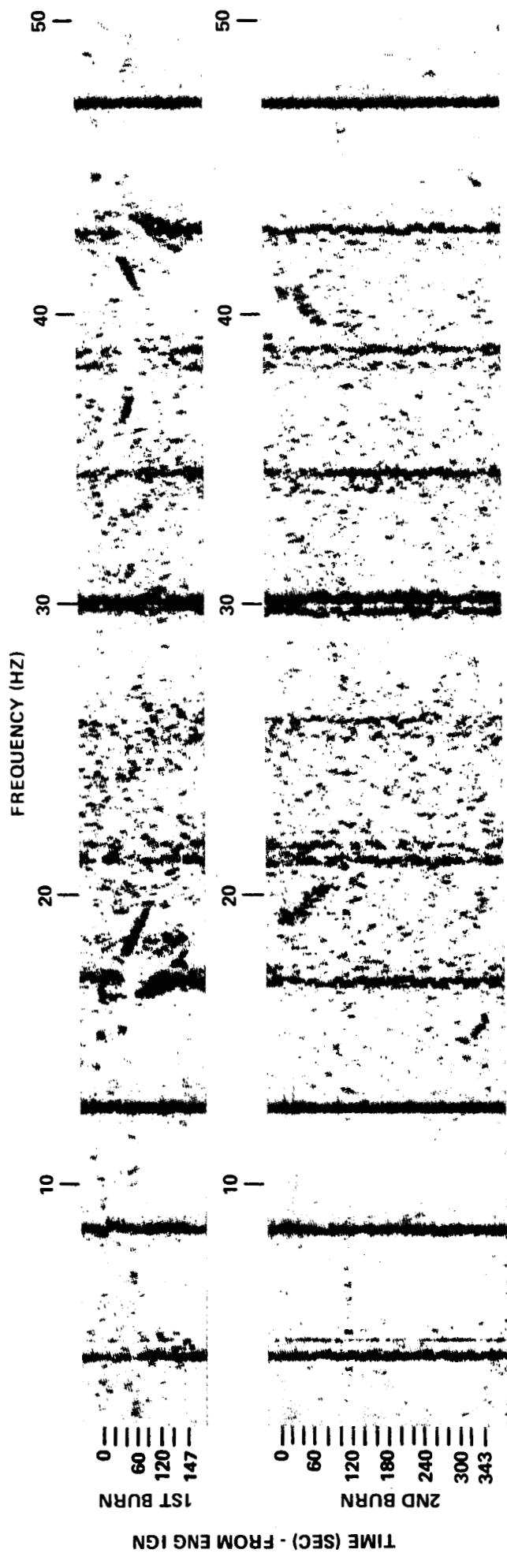


FIGURE 26

AS-505 S-IVB A7-603 IU YAW
(6 BIT)

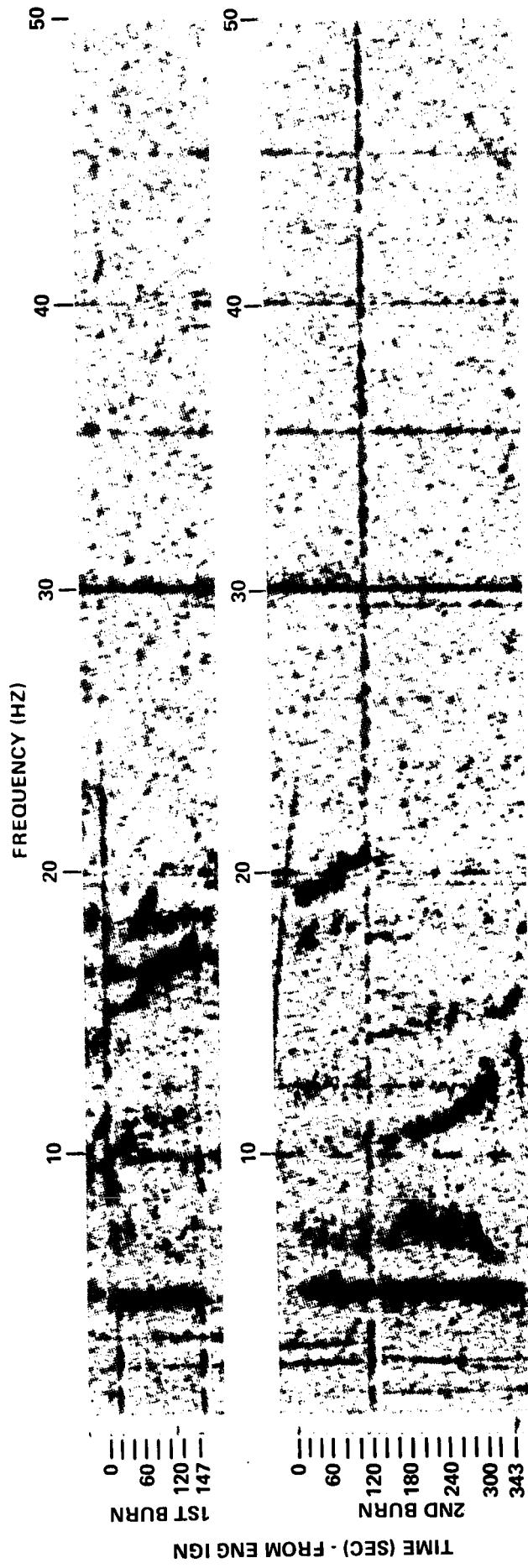


FIGURE 27

AS-505 S-IVB E99-411 FWD BENDING MODE - PITCH
(2 BIT)

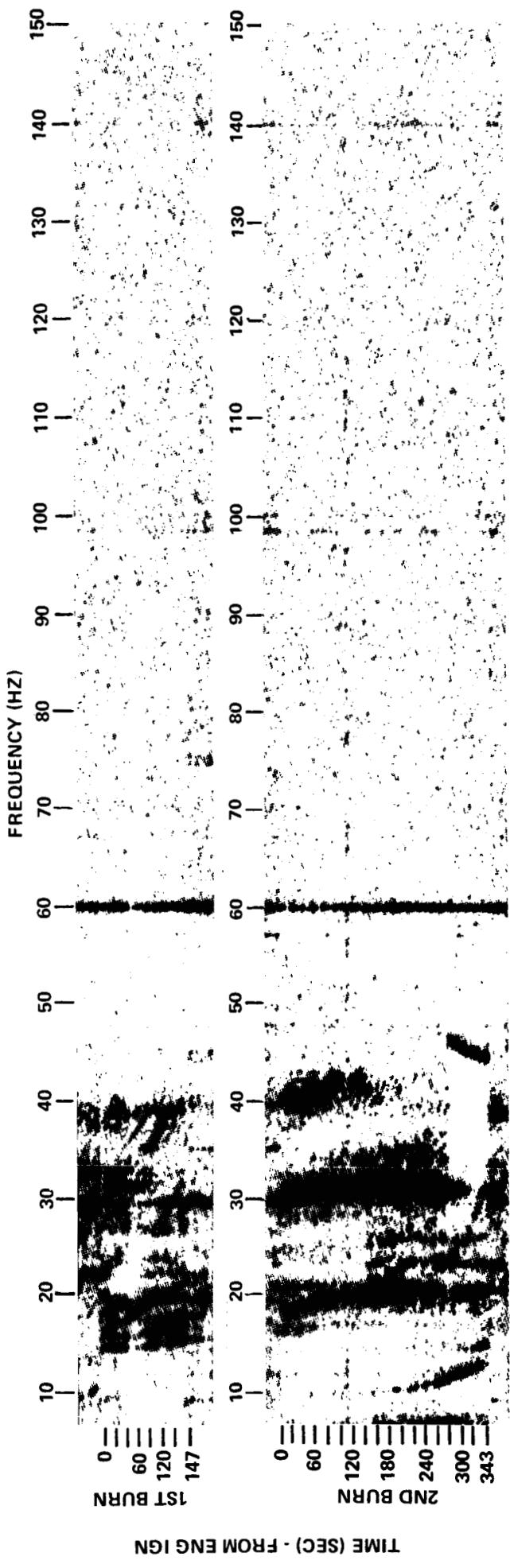


FIGURE 28

AS-505 S-IVB E99-411 FWD BENDING MODE - PITCH
(2 BIT)

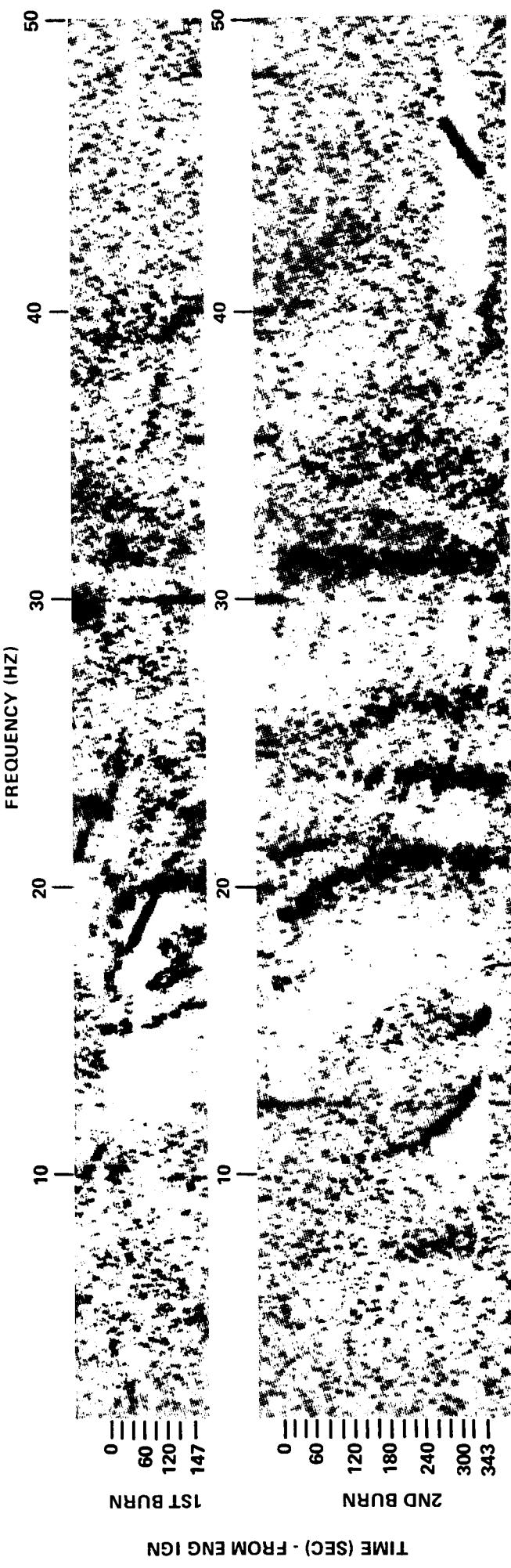


FIGURE 29

AS-505 S-IVB E99-411 FWD BENDING MODE - PITCH
(6 BIT)

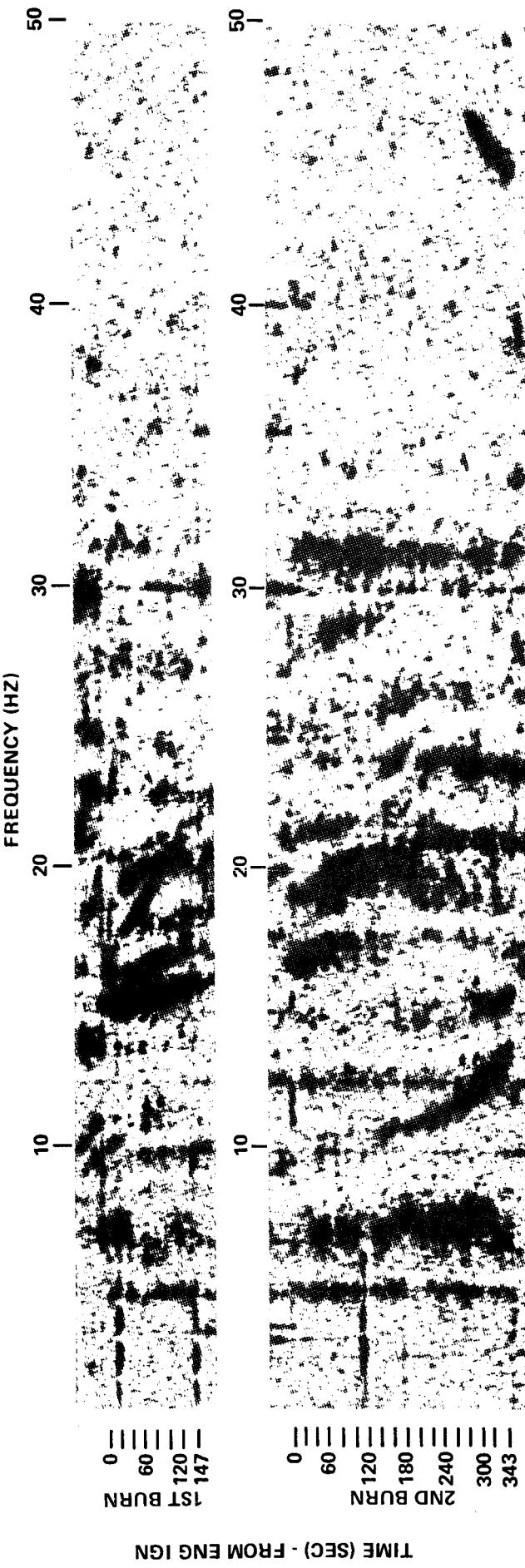


FIGURE 30

FIGURE 31

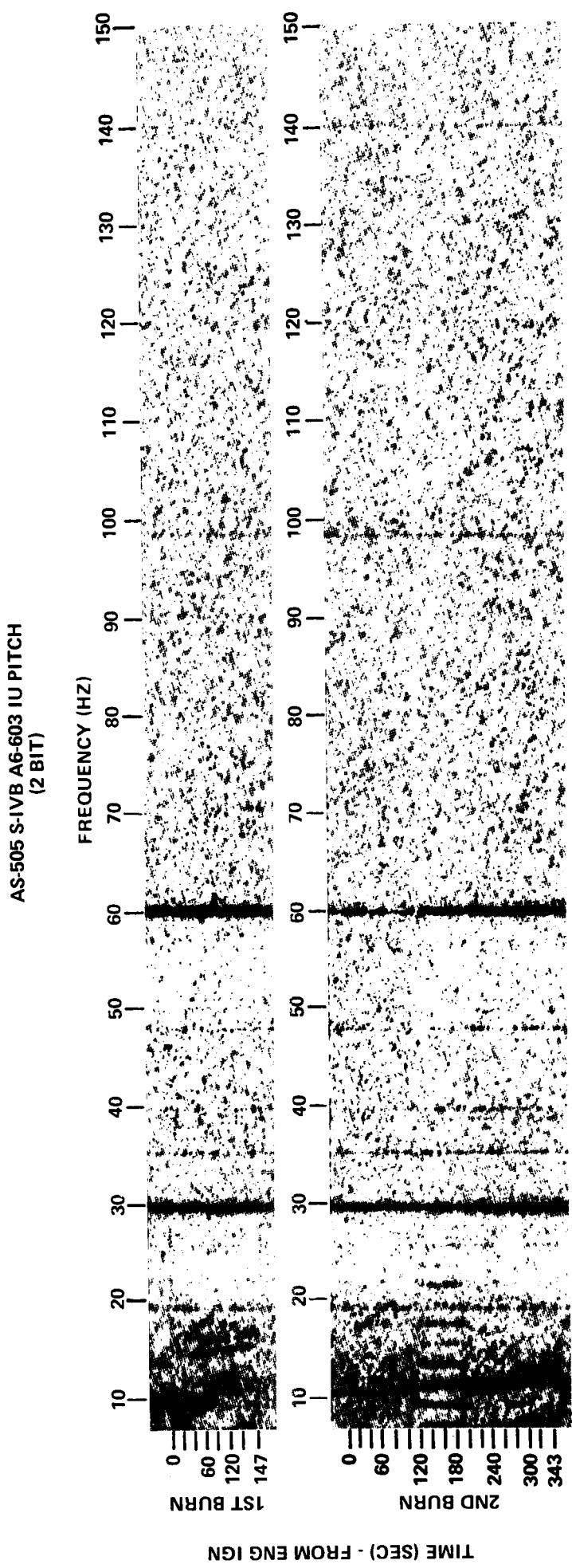


FIGURE 32

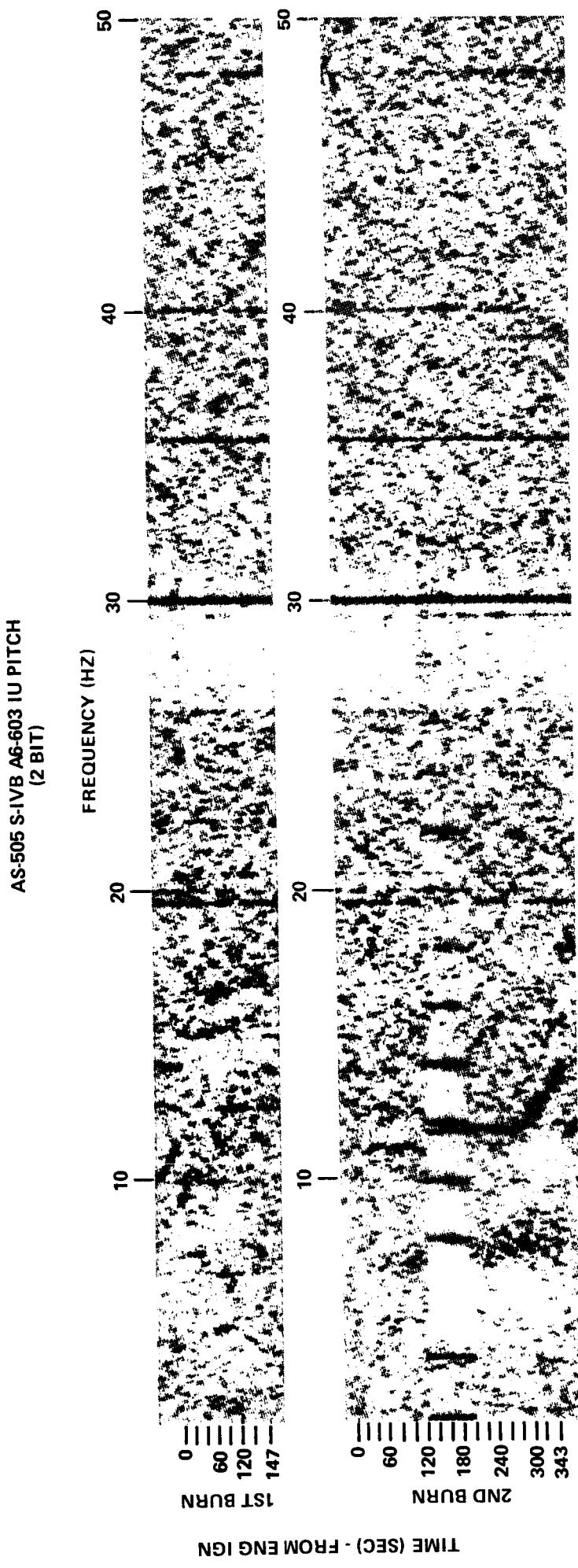


FIGURE 33

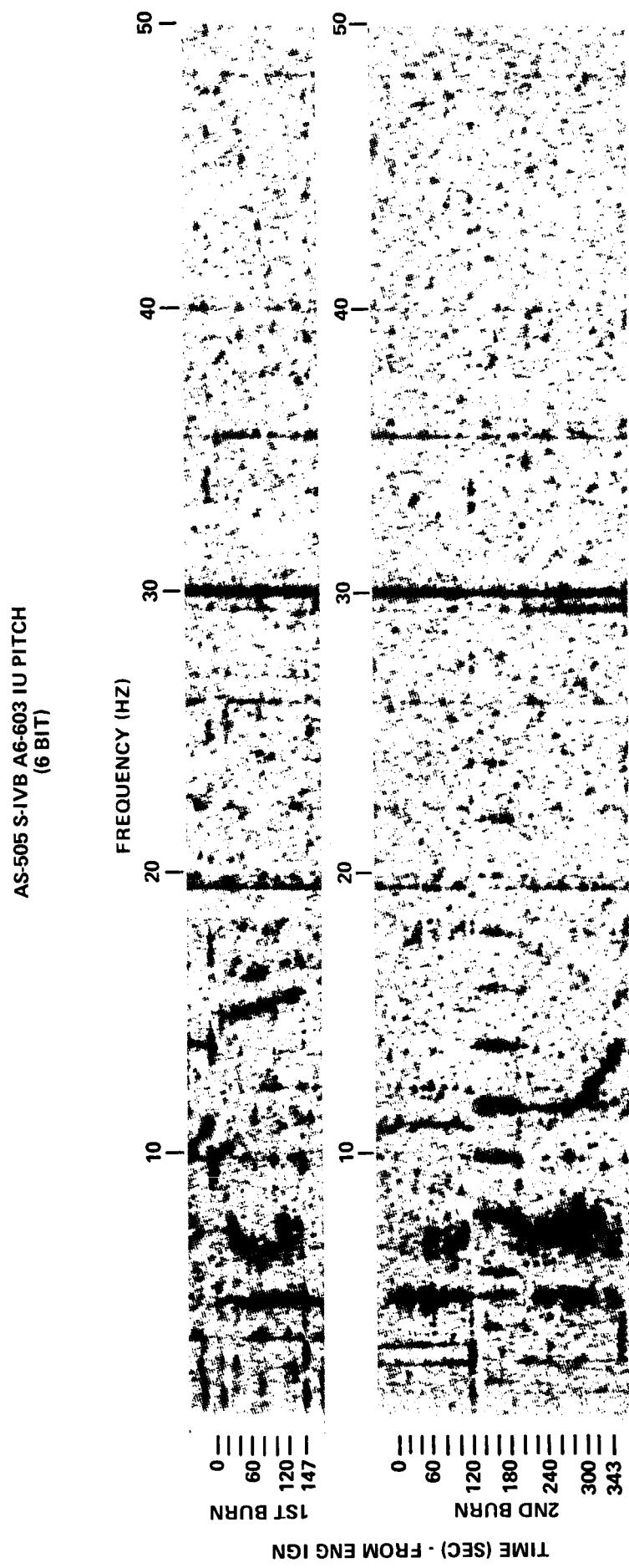
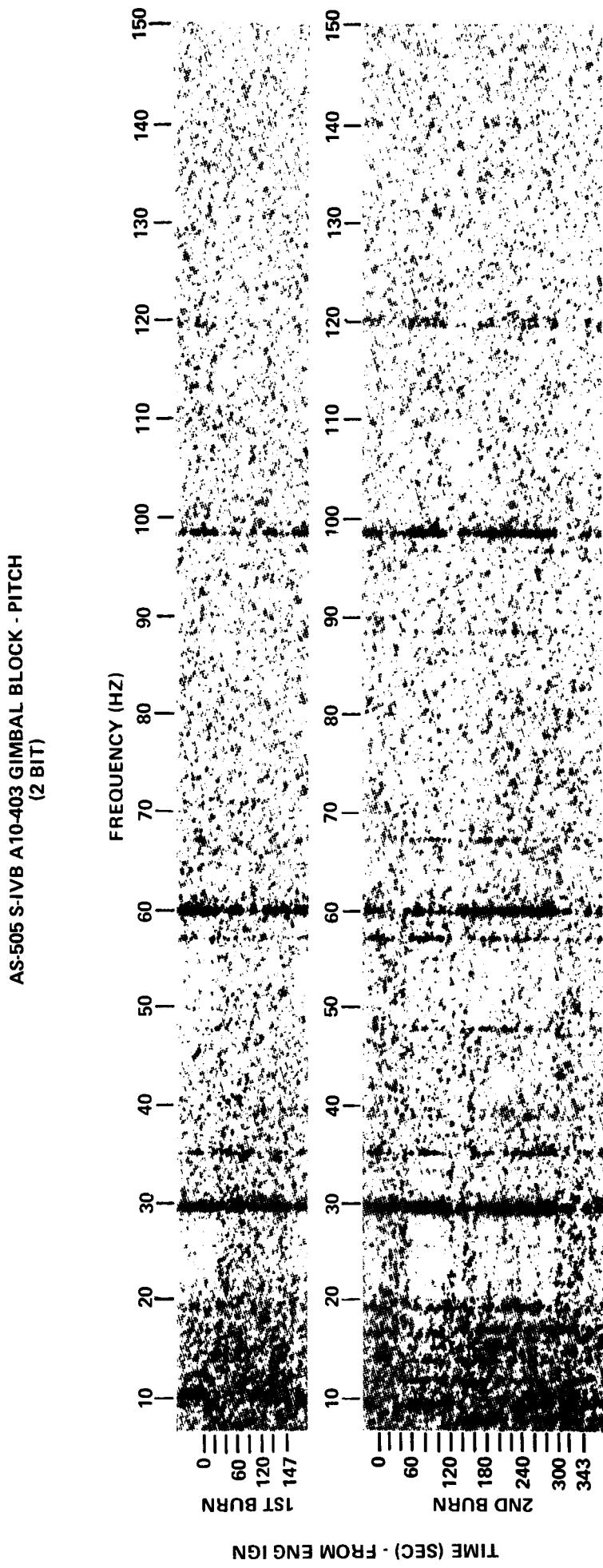


FIGURE 34



**AS-505 S-IVB A10-403 GIMBAL BLOCK - PITCH
(2 BIT)**

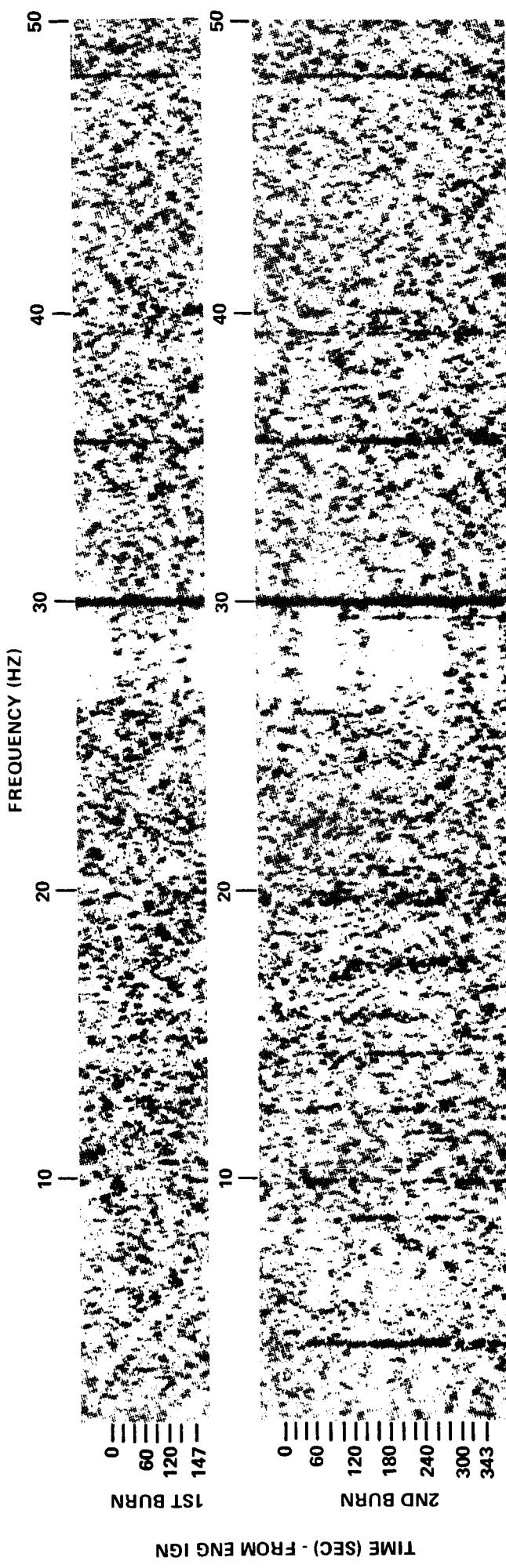


FIGURE 35

AS-505 S-IVB A10-403 GIMBAL BLOCK - PITCH
(6 BIT)

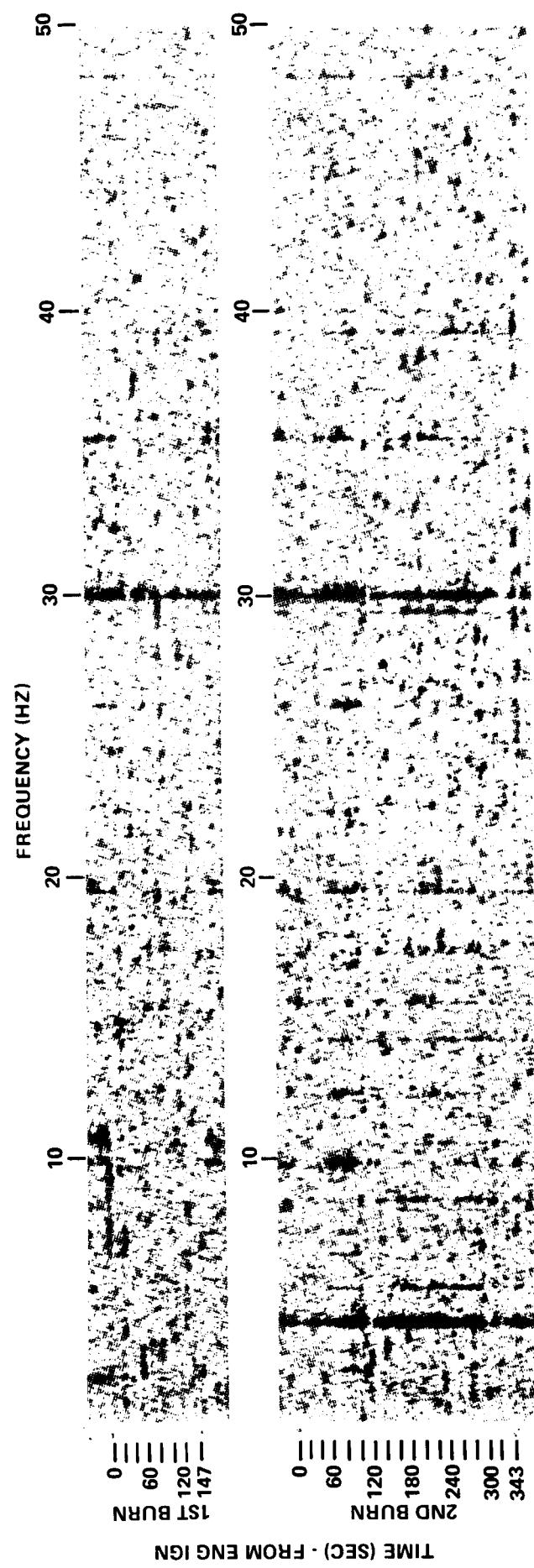


FIGURE 36

**AS-505 S-IVB CM CK 0026A X-AXIS ACCEL
(2 BIT)**

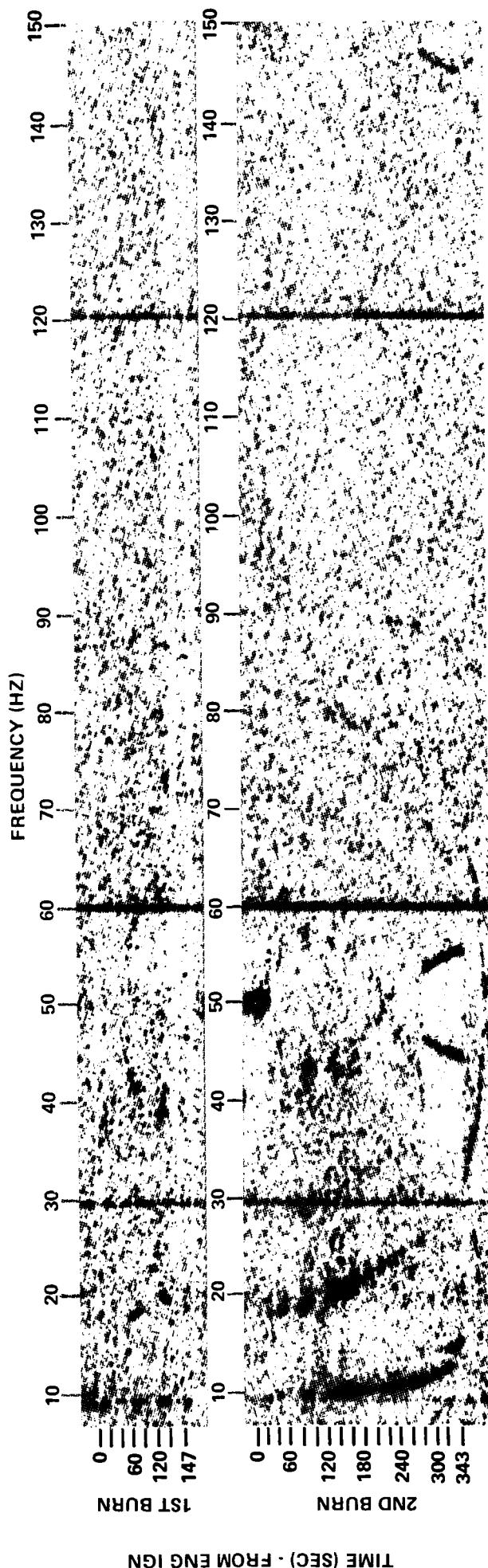


FIGURE 37

AS-505 S-IVB CM CK 0026A X-AXIS ACCEL
(2BIT)

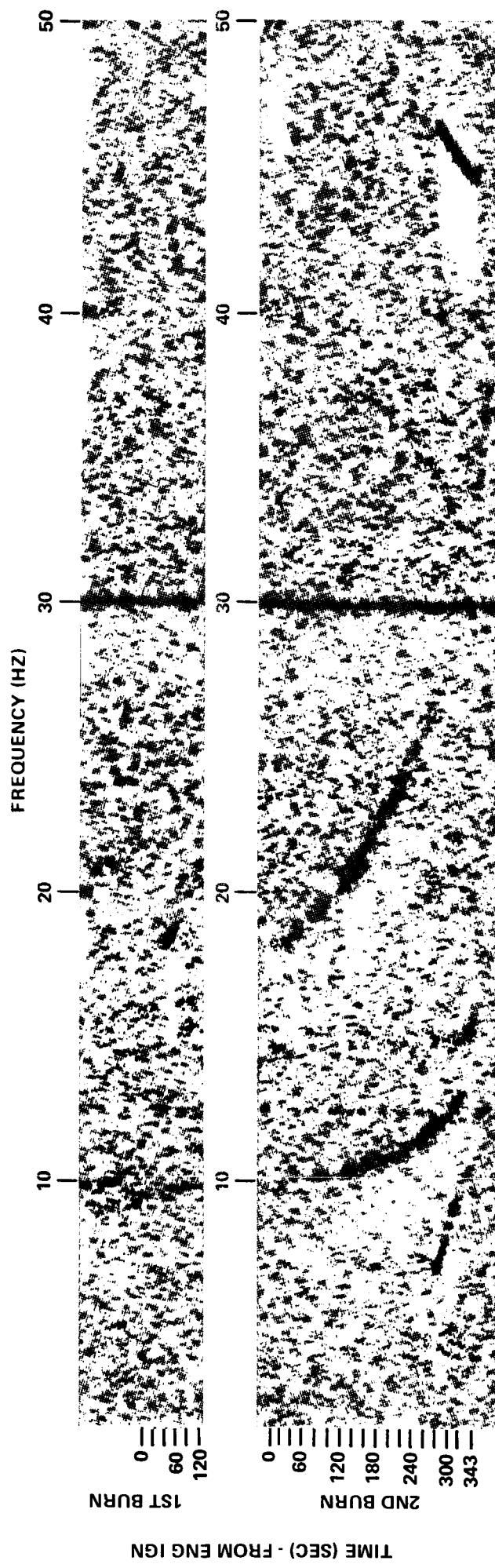
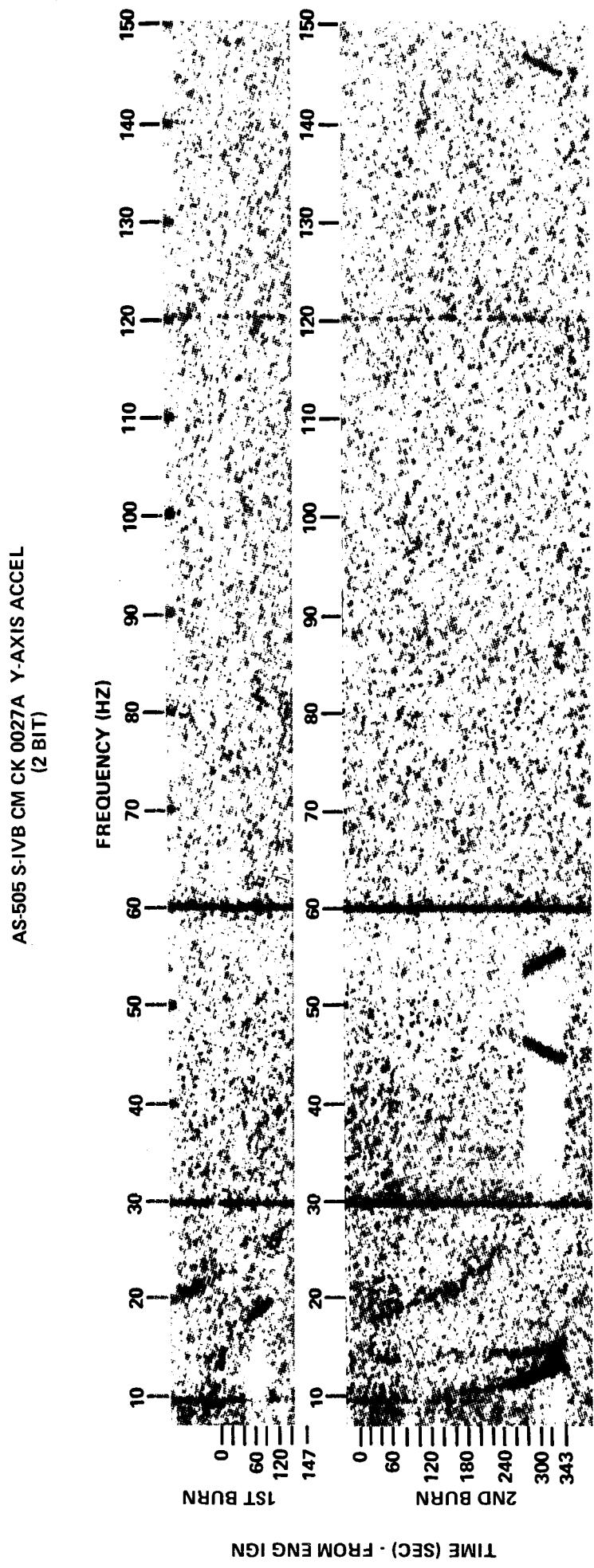


FIGURE 38

FIGURE 40



AS505 S-IVB CM CK 0027A Y-AXIS ACCEL
(2 BIT)

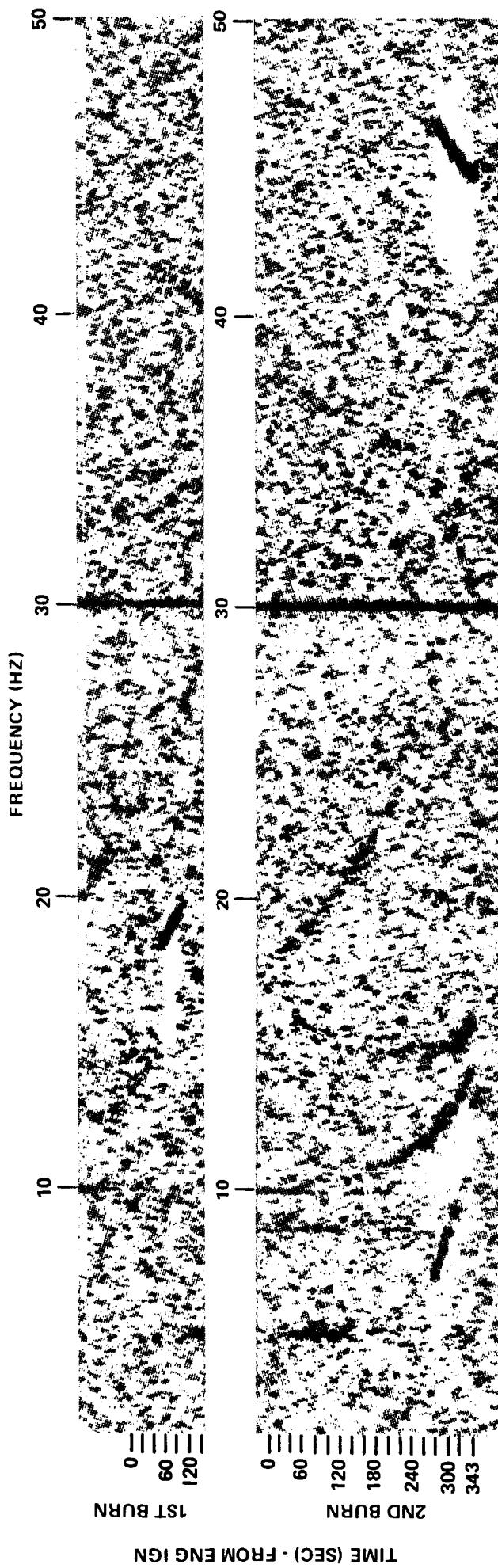


FIGURE 41

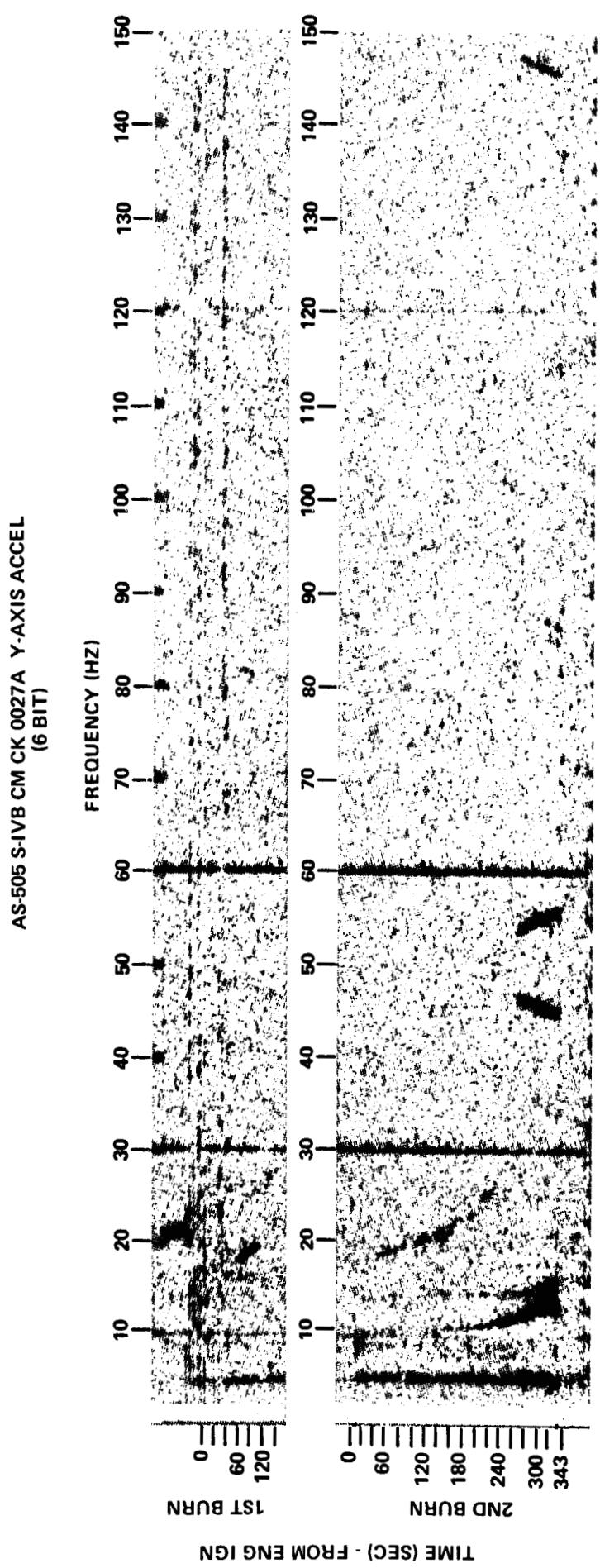


FIGURE 42

FIGURE 43

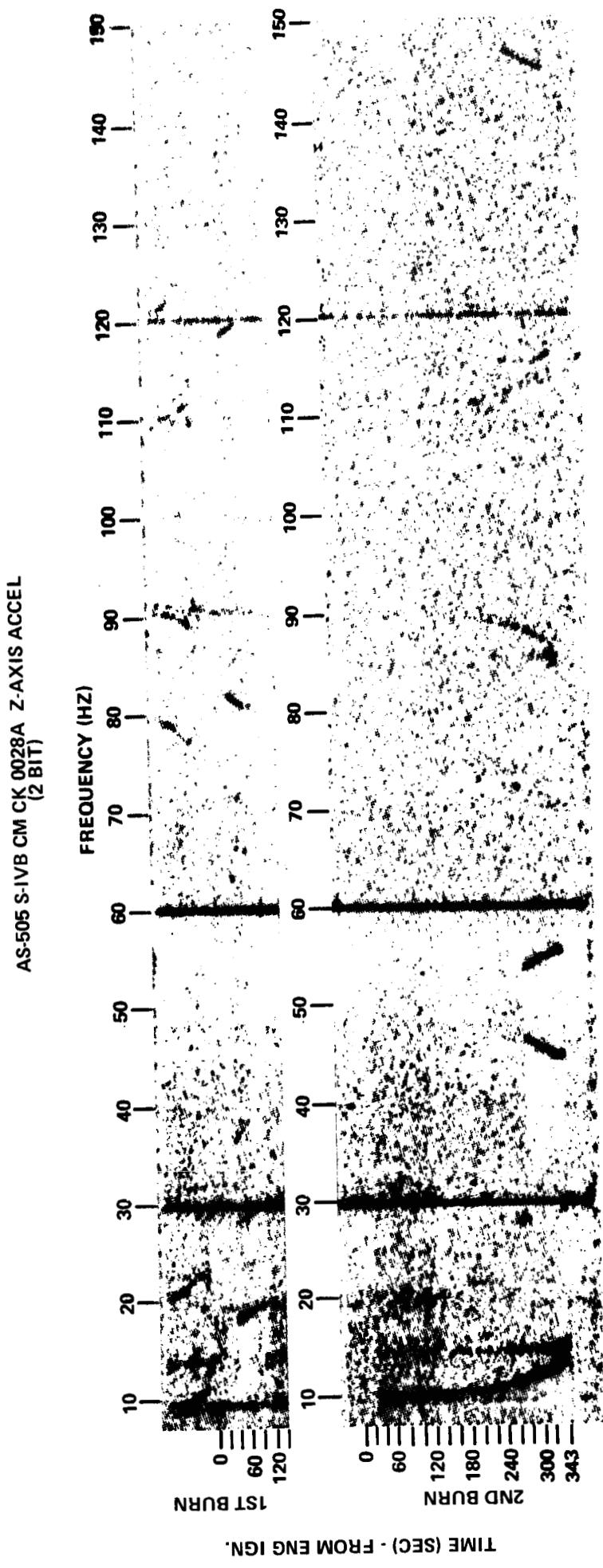
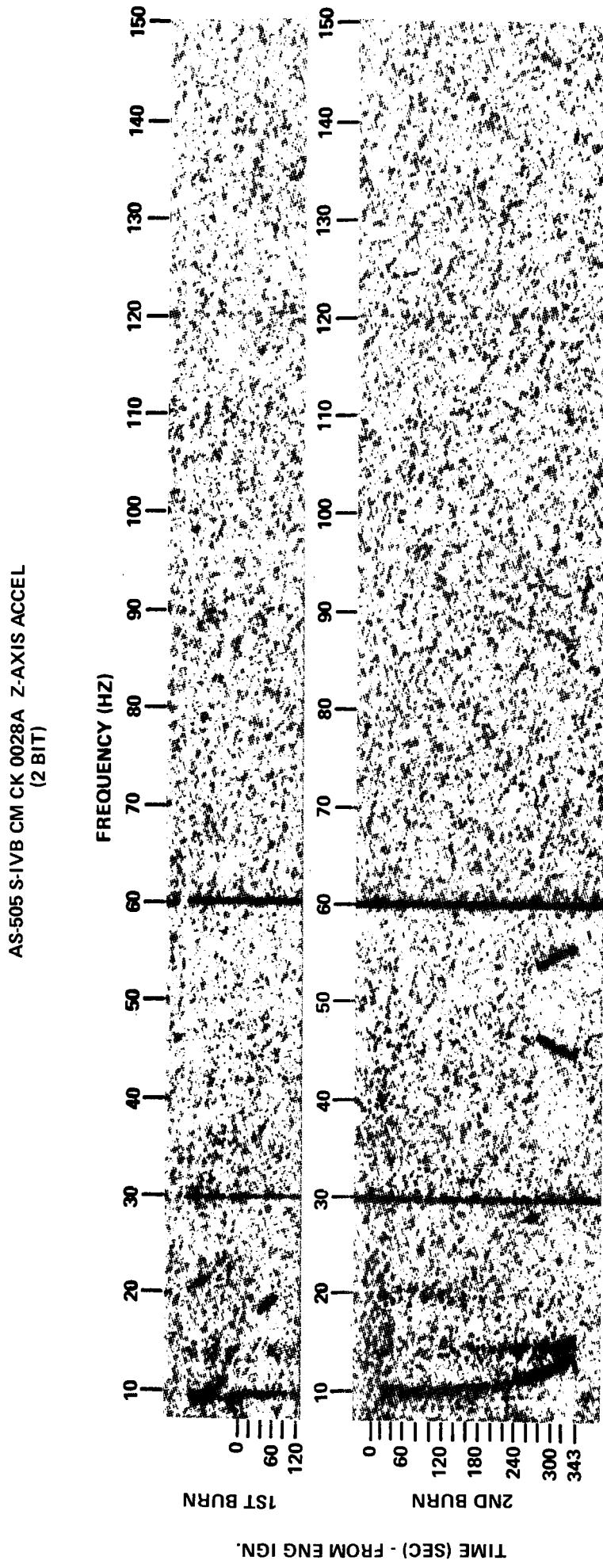


FIGURE 44



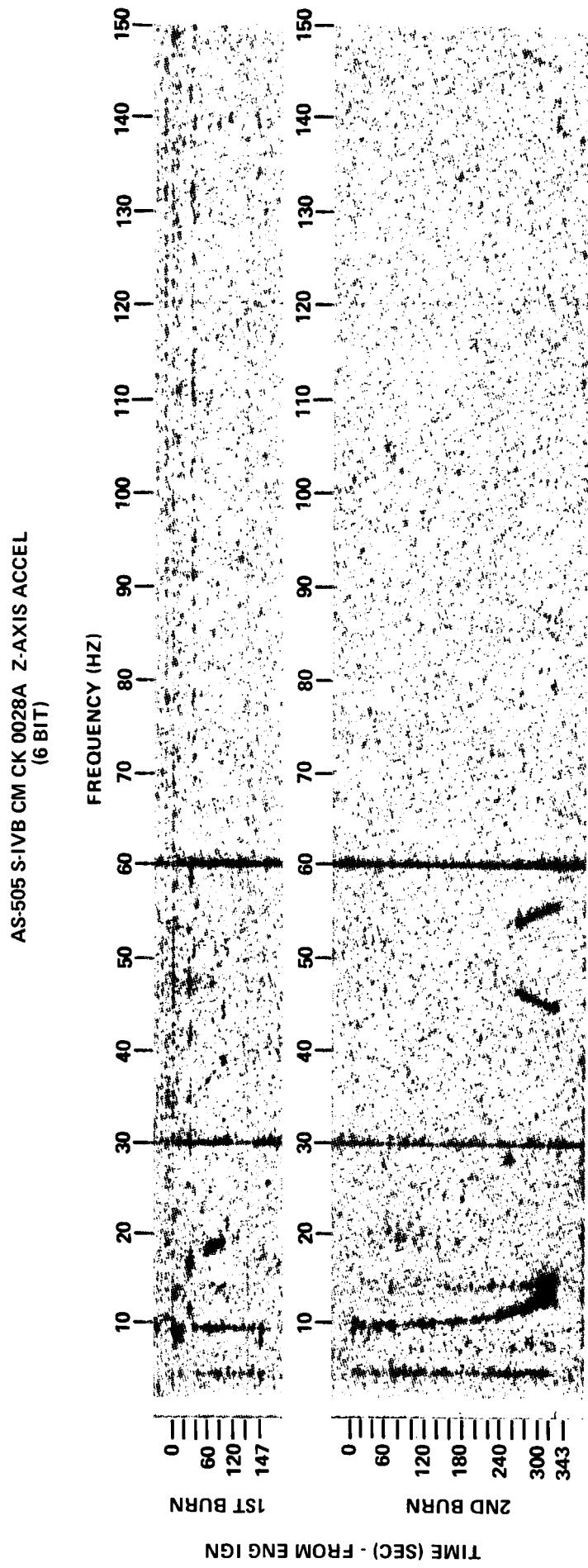


FIGURE 45